Report on the Preliminary Estimates for the Annual Cost of Occupational Illnesses and Injuries in Alberta

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OCCUPATIONAL HEALTH AND SAFETY
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FOREWORD

Every year Alberta workers suffer more than 60,000 job-related injuries resulting in time away from work. The workers' compensation costs related to these injuries are alone more than 400 million dollars per year. The total dollar cost of the problem is estimated conservatively at one-billion dollars per year. There is little doubt that financial and human costs of work-related injuries and illness put considerable strain on the provincial economy, the labour force and industry's ability to compete.

There has not been an appreciable reduction in Alberta's injury rate since the early 1980s. This indicates that perhaps much of what is being done to prevent and reduce accidents and injuries is only managing to maintain a *status quo*. In the meantime, new hazards have appeared and public expectations have changed. The *status quo* is not acceptable. There is a great need to consider new ideas and develop new approaches to the issues surrounding occupational health and safety.

As one consequence of this need, we should begin to speak openly of health and safety as an economic issue. Doing so does not lessen our concern for the human costs of work-related accidents, injuries and ill health, but it does provide an additional lever for promoting action. If, in reality, good health and safety practices and programs not only reduce injuries, but also save money for employers, employees and their families, and governments, why should we not recognize and promote this fact?

The financial cost aspects of health and safety are not currently well-defined or clearly understood, but we know they are significant. This report provides the information necessary to pursue the economic issues, without prejudicing the social ones.

Research studies and data on the financial costs of occupational injuries and illness are very scarce, especially in Canada. I hope that this report will stimulate interested individuals and groups to examine and further develop this facet of occupational health and safety. I also hope that we can continue on from this beginning to an examination of the economic benefits of sound, effective health and safety practices.

Hugh Walker
Managing Director

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SUMMARY

A preliminary estimate for the consequential resource costs of occupational illnesses and injuries in the province of Alberta is presented in the report. The 'most inclusive assessment' of the costs is conservatively estimated to be between $880 and $955 million per year for the years 1986, 1987 and 1988. This number is equivalent to 1.4% and 1.6% of Gross Domestic Product for Alberta. This is considerably higher than comparable estimates in other industrialised nations which account for approximately 0.3% to 0.87% of the GDP. The amount equals the Gross Domestic Product due to grain production in the province and 13% of the corporate profits before taxes. These costs do not include the fixed costs of prevention borne by the government and the industry.

A matrix of cost elements considered in the study is included. The costs have been separated among three major cost-centres: Cost to the Industry, Cost to the Government and Cost to the Workers. The estimates include the 'indirect' costs to the industry in both the WCB and the non-WCB sectors of the workforce. Estimates are provided for the leakage of costs to the Alberta Health Care and the Unemployment Insurance programs for unaccounted cases of illnesses and injuries. Revenue losses to the governments have been estimated. Also included are the longterm costs due to deaths. Earnings losses to the workers are calculated along with an estimate for the subjective components. Detailed cost computations based on the actual 'pay out' or 'loss' to each cost-centre are presented.

A survey of literature on the interdisciplinary principles involved in obtaining the estimates is categorised into six groups. The estimates are derived from existing data sources such as Statistics Canada, Alberta Health, the Workers' Compensation Board in Alberta and Alberta Occupational Health and Safety. These are based on, as far as possible, actual data from these sources and on survey models by other researchers. An annotated bibliography forms an appendix of the report.

The report recommends that approaches to intervention programs be based on consideration of all of the components of cost of occupational illnesses and injuries rather than the payments made by the WCB. It concludes that the estimates for costs are often based on incorrect application of ratios. It also concludes that the indirect cost to the small and medium sized industries is less than what is generally believed.

The report also recommends further work in establishing a standardised model based on provincial and national data-bases for continued development of cost information. Incorporation of occupational information into the general health-care data is a step in this direction. Comparative studies in expenditure/cost relationships between occupational health and safety and other areas of social investments are recommended.

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(I) INTRODUCTION

This report is the result of a project initiated within Alberta Occupational Health and Safety with a view to quantifying the 'most inclusive cost' of the 'problem' of occupational illnesses and injuries in the province of Alberta.

Soaring workers' compensation costs, even though perceived in isolation of rising general health care and other costs, have resulted in new initiatives. These are directed at effecting a downward trend in the numbers of injuries and at containing the compensation costs. In this context it is essential to understand the circumstances surrounding the total cost of the problem as well as the overall magnitude of the costs and their distribution.

Past research, especially in North America, has focused on partial aspects of the problem. Research since the 1950s has estimated costs to the industry or the employers along with those to the various compensation agencies. This report represents a systematic attempt to quantify the total cost to include those to the workers, the government, and the society as a whole.

Of the 1,182,000 workers in Alberta, 876,000 are covered by the Workers' Compensation Board. Approximately 43,000 lost time claims are admitted every year by the WCB for this insured population of workers. These claims constitute the most visible portion of the total costs. The costs of all injuries and illnesses fall into a number of other areas besides the accounting of the claims within the compensation agency. The uninsured population of workers mostly in the service, finance and the agriculture sectors are estimated to suffer an additional 15,000 injuries. Also a number of illnesses attributable to the workplace go undetected through the societal systems. Other components include the 'indirect' costs to the industry and the 'direct' costs due to revenue and wage losses, and leakages to sympathetic systems such as Health Care. These costs are shared by the stakeholders such as the Government and the workers of Alberta.

The report is divided into four sections. The following section describes the scope and the objectives with a detailed listing of the cost-elements considered. The next section presents a review of the literature available on the subject of costs of occupational health and safety. Section three proposes a composite model to determine the 'cost' with details of the computations. Appendices A and B provide summaries of the formulae and the variables. The fourth and last section includes a selection of comparative ratios to provide a perspective and offers some discussions on the broader implications of the estimates.

(II) SCOPE AND OBJECTIVES

The project was undertaken between June 1989 and December 1989. It was designed to take stock of the state of the knowledge surrounding the question of total costs, to examine the data available among the numerous agencies and to determine a preliminary estimate for the cost. The report proposes a model, based on cost-centres, which is composed of the variety of discrete models currently available. These include mathematical, statistical and empirical methods.

The objectives of the project are summarized as follows:

(i) Examine the 'state of the knowledge' through a literature survey.

(ii) Examine sources, such as Statistics Canada, the Workers' Compensation Board, Alberta Health, the Alberta Bureau of Statistics, Alberta Occupational Health and Safety, and Labour Canada, for data which are relevant to the problem.

(iii) Determine a preliminary cost estimate based on a composite model, with stated assumptions, using existing data.

(iv) Identify areas for further development and research.

(v) Discuss some of the broader implications on current occupational health and safety strategies and policies.

The cost-estimate has been limited to the consequential costs of occupational illnesses and injuries. These are the resource or the opportunity costs which may be assigned to alternate purposes.

The estimate does not include the fixed costs of prevention measures. These costs arise even when there is no additional injury during a given period, and therefore are not regarded as the result of the 'incremental' injury.

The study also excludes the consideration of downgrading incidents resulting in costs but not associated with injuries or illnesses. We have also excluded the estimates for costs associated with stress-related illnesses. Similarly, estimates for the proportion of general absenteeism rates within the industry which are often attributed to occupational health issues, are not included.

The detailed inclusions and exclusions of the cost-estimates are presented in the following table.

MATRIX OF COST ELEMENTS IN THE STUDY

	INCLUDED	EXCLUDED
Cost due to proportion of absenteeism attributable to occupational issues.		X
Cost of stress-related illnesses.		X
Cost of non-injury incidents.		X
Cost due to the Federal employees in Alberta.		X
COST TO INDUSTRY		
Total population of workers:		
For Lost-time and Minor Injuries:		
(1) Uninsured time for victim	X	
(2) Administrative time (consequential)	X	
(3) Work-stoppage (consequential)	X	
Assistance to victim	X	
Transportation	X	
Interruptions/inefficiencies	X	
(4) Replacement and training	X	
(5) In-house medicine*	X	
(6) Ambulance costs*	X	
(7) Legal fees*	X	
(8) Labour for clean-up*	X	
Cost of Material damage for injury incidents	X	
Cost of Fringe Benefits paid by insured employers	X	
Variable cost of prevention*	X	
Fixed cost of prevention		X
Financial losses to employer due to loss in value-added	X	
COST TO GOVERNMENT, INTERMEDIATE AGENCIES & SOCIETY		
Consequential costs paid out by WCB:		
Compensation payments	X	
Pension awards	X	
Vocational rehabilitation	X	
Treatment costs due to rehabilitation, health care payments, prosthesis etc.	X	
WCB Administration, operation and research costs:		X
Revenue losses to the Government due to:		
- WCB payments	X	
- workers' reduced earnings	X	
- employers' financial losses	X	
- occupational disease mortalities not recognized within the Compensation system	X	
- earnings losses to injuries for uninsured workers	X	

	INCLUDED	EXCLUDED
- occupational disease morbidities not within the compensation system		X
Variable costs of prevention to Government	X	
Fixed Costs of prevention to Government		X
Cost 'leakages' to general Health Care system due to:		
- unreported cases of occupational diseases in selected categories for insured and uninsured workers	X	
- treatment of uninsured workers	X	
- misdirected billings into the Health Care system		X
- higher than average attention to past victims		X
Costs of unemployment insurance payment:		
To uninsured worker	X	
To insured worker due to long-term effects		X
Costs of long-term wage-losses:		
Due to mortalities	X	
Due to morbidities**	X	
Costs of rehabilitating the 'uninsured' worker		X
COST TO WORKER		
Reduced earnings when on compensation or pension	X	
Wage-loss of the 'uninsured'	X	
Subjective elements due to loss of potentials, pain and suffering***		
Due to all cases of mortalities	X	
Due to occupational disease morbidities outside of the compensation system		X

NOTES:

* Allowances assumed for.

** Assumed to be compensated for within societal systems.

*** Includes an inseparable 'non-resource' component due to pain and suffering.

(III) LITERATURE REVIEW

This literature review provides the background for the methodologies used for the assessment of the cost of occupational illnesses and injuries. It is intended as a collation of the inter-disciplinary principles available for work on the subject. An annotated bibliography is provided as a supplement to this report.

Literature dealing with the costs of occupational health and safety may be grouped into 6 broad categories. These are listed below.

A. The first category consists of research into the costs to industry directed at establishing the 'hidden' costs, i.e., the costs beyond the direct expenditures associated with the injury or illness.

B. The second group deals with models which provide for composite cost estimates for the 'problem' of occupational health and safety.

C. The third category comprises epidemiological studies providing estimates for proportions of selected categories of diseases which are attributed to occupational reasons. These estimates are not normally represented within the classical estimates for occupational injury or illness cases.

D. This category consists of economic valuation studies in respect of the long term consequences of loss of life, or disabling injuries and illnesses. Value imputations to life are more common than those to disabling cases.

E. The fifth group consists of cost studies associated with specific maladies, such as hearing loss, back injuries, etc. A number of these are directed at occupational cases, while others, such as those for cancer, investigate diseases within the general health care field.

F. The last category within this review cites examples of cost-benefit studies for selected health and safety programs. A few of these studies are directed at legislative programs, while others address aspects of health and safety programs and initiatives within individual companies.

The last two categories are not directly relevant to the objectives of our project. However, these are included in the review as being indirectly related, and may prove to be of value while conducting further work in some areas.

The literature search was unable to identify or examine work done to determine the revenue losses to the government, or the losses to the workers. Models which account for leakage of costs to sympathetic systems outside the workers compensation schemes, such as unemployment and other insurances were also unavailable.

A. Research into Costs to Industry

The earliest and the most well known work in this category is a 1926 study done by H.W. Heinrich (1931) based on an examination of 5,000 case files for enterprises insured with a private insurance company. The study led to the oft quoted 'indirect' to 'direct' cost ratio of 4:1. Direct cost was defined as the amount paid out by the insurance company. Indirect cost was categorized as the total for the costs of first aid, transport of victims, work time lost by the victim and other employees, replacement of workers, restoration of means of production, losses of production and profits, and the share of general costs paid out without equivalent returns. Only the costs incurred by the enterprise or the insurance company were included.

Heinrich's work was a pioneering effort and for nearly three decades constituted the 'standard' in the field. The value of the work may be judged by the fact that despite its deficiencies, it is still the most quoted work among occupational health and safety professionals. A number of deficiencies have been noted, however, by later researchers. The computed ratios between the 'indirect' and 'direct' costs suffered from a very wide range in values. The study has also been criticised for bias towards the more significant workplace incidents, which minimized the impact of the more common and 'simple' occurrences. A subsequent edition of the publication was revised to include the cost of material losses due to all incidents, whether resulting in injury or not, without a change to the ratio. Furthermore, the two classes of costs suffered from 'double-accounting' and included items which were not always demonstrable. The criticisms aside, the study is now dated if only due to the fact that the medical costs and the principles for compensation in the 1920s were radically different than those existing today. The 'direct' cost due to insurance payments against claims was correspondingly minimal. Subsequent work by a number of researchers have failed to substantiate the ratio of 4:1, and alternative ratios or methods have been suggested.

Research done by Simonds and Grimaldi (Grimaldi, 1975), proposed an alternate method for estimating the indirect costs to industry. The method uses four classes of incidents:

1. lost time injuries resulting in total temporary incapacity to work or permanent partial incapacity, fatalities are included in this category;
2. 'doctor injuries' resulting in partial temporary incapacity;
3. 'first aid' injuries, more commonly described as 'minor injuries'; and
4. material damage cases.

Average costs for each class of injury were established for the 'uninsured' and the 'insured' elements. The 'uninsured' elements, for example, are estimated through a survey, at $220 for lost-time cases, $55 for the 'doctor injuries', $12 for the first-aid cases and $400 for the no-injury case, for the year 1974. The 'insured' elements are represented through the actual pay-outs by the insurance agencies. The definitions of these two elements follow closely those for 'indirect' and 'direct' costs proposed by Heinrich, without being exactly identical. Simonds and Grimaldi, however, suggest that the terminologies are interchangeable. The differences between the two sets of definitions arise largely out of the elimination of a few of the 'undemonstrable' elements by Simonds and Grimaldi. One example of such an element is the cost of lower employee morale. The calculations for the 'loss in profit' are also based on more realistic assumptions.

Ratios are established from industry records between the numbers of occurrences of each class of incident. These are then applied to the average costs for the type of incident and total costs are computed.

The basic methodology, using the different classes of incidents and their costs, continues to form the basis of the annual estimates published by the National Safety Council (NSC) in the U.S. An average ratio (1:1) between the 'uninsured' to 'insured' costs is loosely applied only when no data are available, and companies are "encouraged to estimate their own costs" in line with a standardized accounting model.

Other researchers, such as Bird, Fletcher, and the British Safety Council (cited in Andreoni, 1986) have independently established ratios among the different types of injuries and incidents, with some variations to the definitions employed. The Bird study encompassed 297 U.S. enterprises covering 1,750,000 incidents. Fletcher's work covered 50 factories in 12 countries belonging to a single company. The British Safety Council research covered 2,000 enterprises from all sectors of the economy. The ratios established between 'minor' non-lost time cases and those resulting in major occupational injuries, are 10:1 (Bird), 19:1 (Fletcher), and 12.5:1 (British Safety Council). The British Safety Council ratio has been adjusted to be consistent with the definition of a lost-time injury in Alberta. The Fletcher study was based entirely on data related to a single company, rather than those from multiple enterprises.

Laufer (1986) investigated uninsured incident costs incurred by medium sized construction firms in Israel and found that the ratio is 0.2:1 (uninsured costs : insured costs) for cases with injuries and 0.3:1 for the entire sample including non-injury incidents. Average total incident costs were computed to be equivalent to approximately 100 manhours and to 0.76% of the project labour costs. The research was conducted through interviews within the construction industry for 210 accidents.

Leopold and Leonard (1987), conducting a similar study based on the investigation of a sample population of incidents in the construction industry in the U.K., estimated the uninsured costs to be 7.3 Million British pounds and the insured costs at 83.1 Million British pounds for the year 1981. This represents a ratio of 0.09:1. The representative sample was constituted of 5% in fatalities, 15% in major disabling injuries and a large per cent of injuries resulting in 3 or more lost days, the threshold absence for lost time claims in the U.K.

Both studies used methodology based on the classification of costs defined by Simonds and Grimaldi. Direct costs included the wages, legal costs, material costs, cost of medical treatment on site, incremental insurance premium and similar direct outlays by the company. Minor injuries were not included. The studies were also limited to the construction industry. The representative sample used by Leopold and Leonard appears to include a high proportion of fatalities.

Both studies conclude that for the majority of companies indirect costs are too small a proportion of the total costs to act as an incentive, and that only the large firms stand to benefit from the reduction in injuries resulting ultimately in a reduction in insurance premiums.

In Canada, a recent study by Brody, Rohan, Letourneau and Poirier (1989) of the University of Montreal and the Institut de Recherche en Sante et en Securite du Travail du Quebec (IRSST), asserts a ratio of 0.83:1 with a range between 0.59 to 1.2 between 'indirect' and 'direct' costs. The lowest ratio is in the Material Transportation industry and the highest is in the Plastics industry. The research covered 490 Quebec firms in primary and secondary sectors in 13 industries. Only firms employing 100 or more employees were surveyed, and lost-time injuries resulting in claims but involving no more than 60 disabling days were considered. Brody et al (1989) also provide data on the distribution frequency of the various components of the costs. The average indirect cost per injury was computed at $1156 and the direct costs at $1391.

The study is in its first stages of publication at this time. However, it would appear to be the first attempt to establish the causalities due to significant variables in the ratio between 'indirect' and 'direct' costs. A multiple regression model is proposed to account for the simultaneous impact due to three classes of variables, such as company characteristics, injured worker characteristics and accident characteristics. So far, published details indicate that age, days lost, type of industry, production capacity at the time of the accident and the establishment size are among the statistically significant variables. Accident type, body part affected, length of training and size of the department have been found to be statistically insignificant.

Another study presented at the 1987 Conference of the Human Factors Association of Canada by Ginpil (1987), suggest the use of 25% of the lost workdays by a worker as the labour unit value of indirect costs to the company. This was based on client data obtained in the U.S. and Canada, by the consulting company Humantech Inc.

Diego Andreoni (1986) in an International Labour Organization (ILO) publication provides a comprehensive review of the research undertaken. Some 40 items of research in 8 different countries, representing both market and planned economies, are quoted.

A number of publications are also available in the area of cost-accounting of accidents. The Humantech paper, referred to earlier, offers one such model. The bibliography contains a selection of these articles. The majority are by safety professionals and describe management accounting approaches to the costing of accidents in individual enterprises.

Organizations providing health and safety program services, such as the International Loss Control Institute (ILCI) also propose ratios between 'indirect' and 'direct' costs to industry. These models suffer from problems due to the extrapolation of data from 'unique' instances to arrive at 'statistical' models. While the case studies may be accurate for a particular incident or establishment, the use of the ratios on a provincial or national base leads to unacceptable errors.

Indirect and direct costs to industry have been the subject of probably the most exhaustive studies. Yet, so far, no clear methodology has emerged as being universally applicable.

The 'ratio model' proposed by Heinrich suffers from the problem that the sole determinant of the indirect cost is the value of the direct cost. Since direct costs vary enormously between the types of injuries and between enterprises, reliable estimates are unlikely using this model. The widespread use of this ratio in the past has been the cause of considerable scepticism.

The 'type model' as proposed by Simonds and Grimaldi affords some corrections in accounting for some of the variables. Brody's research may provide a more reliable methodology, if only due to the fact that it is conducted in the Canadian context. Technically, the most significant strength of this study is in the accounting for a number of variables. However, the model may be limited due to the size of the firms (> 100 employees only), the number of disabling days (< 60 days), and the fact that only production workers were considered.

B. Composite Models

Very few studies, none detailed in the North American context, are available to deal with the overall costs of occupational illnesses and injuries. The most comprehensive treatment of composite cost is provided by the ILO publication by Andreoni referred to earlier. The publication identifies the variety of costs associated with the problem of occupational injuries and illnesses, and suggests methodologies at the micro and the macro level in varying degrees of detail. Diego Andreoni (1986) establishes four cost centres. These are:

1. costs to the worker;
2. costs to the enterprise or the industry;
3. costs to intermediate agencies, such as the Workers' Compensation Boards and other insurance agencies, Workers' and Employers' organizations; and
4. costs to the country which essentially lists the costs to the Government due to the revenue losses, long-term consequential losses and the 'leakages' to other social support systems.

Andreoni's model is aimed at countries around the world and deals with a number of items peculiar to countries with economic and social systems not encountered in Canada. Determination of costs is recommended using a combination of mathematical, statistical and empirical models, at both micro and macro levels. The study, however, deals with the process and does not provide actual data. The bibliography refers to some 200 publications and research papers, a number of which provide excellent information. One of the major difficulties in the study has been an inconsistent definition of cost. This results in overlaps between cost centres and possibly, 'double-accounting'.

An empirical analysis of the macro-economic consequences is provided in a Federal Republic of Germany study by Franke and Jokl (1975). This estimates the total 'economic' cost of notifiable occupational accidents, commuting accidents and trivial accidents at Deutsch Mark (DM) 12.4 billion, or DM 20 billion if long term consequences are included. The amount is based on some 3.2 million accidents in 1970. This averages at a cost per accident of DM 3,875 or, DM 6,250. The total cost of 12.4 billion represents approximately 0.3% of the German gross national product (DM 4,200 billion) in 1970. Or, 0.5% if long term consequences are included. It is uncertain if the costs of illnesses are included. Andreoni quotes the same work in his publication (p. 26, 1986) as having computed the residual costs to the individual finances of each German worker to be of the order of 25% of the subsequent costs of an injury. Unfortunately, only an abstract in English was available.

Two other pieces of work, both from the U.K., were reviewed for this category. The first of these is possibly the first thorough effort at quantifying the 'resource' costs of occupational accidents and diseases. This is contained in an appendix of the Robens Committee Report on Safety & Health at Work to the House of Commons (1974). The appendix was prepared by the Research & Planning Division of the Department of Employment.

The report contains a valuation for the subjective costs i.e., "the intangible value of life and good health free from accident or disease". The cost of this portion is estimated at between 52 million and 78 million British pounds for the year ending June 1969. The values are derived from such items as insurance payments, compensation and court awards, and other implicit valuations from observed institutional and sociological phenomena, based on a study by the Road Research Laboratory in the U.K. on the value for risk-avoidance.

Another item of note is the validation, through a sample survey of employers, of the case for under-reporting of occupational accidents in the U.K. A 2 1/2% random sample in 1969/70 showed that 27% of the accidents which were clearly reportable, had not been reported. The proportion of severe injuries in the unreported cases (7.5%) was significantly lower than in the complete 5% sample of all reported cases (18.4%). The degree of under-reporting varied between the industries. The construction industry in the U.K. topped this list with approximately 40 - 50%. However, these numbers are to be viewed in the context of reporting requirements which vary considerably between Canada and the U.K.

In the estimate, data on prescribed diseases are included from both the Factories Inspectorate and the Department of Health and Social Security (DHSS). The DHSS statistics cover a wider number of industries than those from the Inspectorate. The total resource cost is estimated at ranging between 550 million and 900 million British pounds. The number of cases considered are 2,000 fatalities, 841,680 incidents of all types and an unknown number of prescribed diseases for the year. The resource costs (which include those for prescribed diseases) amount to between 0.54% and 0.87% of the Gross National Product (GNP). The latter number includes the subjective costs.

The second study in the U.K., by Morgan and Davies (1981), is a follow up to the Robens estimate as an update of the numbers. This study is based on the 1978 - 79 records and revises the total estimate to between 0.8% to 1.2% (1.2 - 1.4 billion pounds) of the GNP. This estimate includes the costs of non-injury accidents, which partially account for the elevated estimate.

The Robens estimate uses 'resource cost' consistently throughout its approach. The estimate for the total would appear to be low in comparison with the estimates derived later in this report. However, the GNP ratio provides an acceptable comparator. This is based on the assumption that if the economy and the social solidarity systems are similar between the two countries, the ratios are likely to be similar. The actual cost, however, may be higher or lower reflecting the wages and the costs of compensation systems.

Among the Canadian studies which refer to the total costs of occupational injuries and illnesses, are a technical report by Manga, Broyles, and Reschenthaler (1981) and a study by Smart and Sanders (cited in Manga et al, 1981) and by Naquin (1979). These quote ratios of 2 to 10 times to be applied to compensation payments by Workers' Compensation Boards to arrive at the "total costs". However, a definition of the total costs and the basis for the derivation of the ratios are not stated. A Labour Canada publication (1985) titled Industrial Accident Costs (1969 - 1979) uses Heinrich's ratio of 4 : 1 to compute indirect costs and asserts a total of $7.2 billion in 1980 for the costs of work injuries and industrial investment in prevention in Canada. However, the report is based entirely on the WCB costs and a U.S. survey on investments on health and safety.

C. Epidemiological Studies

While much attention has been paid to the cost of traumatic injuries due to accidents in the workplace, recognition of the cost of occupational diseases as part of the overall problem has not developed to the same extent. As a result the contribution to the total cost due to occupational diseases is under-reported. The long latency period leading to difficulties in linking occupational exposure to the disease and the adoption of a limited list for occupational diseases by some compensation agencies are among factors which contribute to the under-reporting.

The case for under-reporting of occupational diseases is supported in literature. A number of these are quoted in a Report submitted by Landrigan and Markowitz to New York State Legislature (pp.16-17, 1987). A U.S. Department of Labour study indicated that only 5% of the workers severely disabled by occupational disease receive compensation benefits. Discher et al (cited in Landrigan and Markowitz, 1987) in Washington state reported 3% as the proportion that submitted claims.

Although the relationship between individual hazards and the resultant diseases have been known for some time, macro estimates for the proportion of diseases due to workplace hazards are the subject of more recent research. The OSHA (Occupational Safety and Health Administration, U.S.) paper submitted to the

Secretary of Health, Education and Welfare in the U.S. in 1978, produced the first of such estimates. Examples of estimates for incidences of occupational cancers, as a proportion of total cancers, are: 23-38% (OSHA - 1978, cited in Doll and Peto, 1981), 10% (Landrigan and Markowitz, 1987), and 2-8% (Doll and Peto, 1981). Some controversy surround the numbers for cancers. However, the estimates provided by Doll and Peto for occupational cancers in the U.S. are widely regarded.

Other estimates have been provided for chronic respiratory diseases, cardio-vascular disease, renal disease, and for neurological disorders. In each case, the most recent estimate stands at between 1 - 3% of all cases (Landrigan and Markowitz, 1987).

These estimates are applied equally to the mortality and the morbidity cases in the report by Landrigan and Markowitz. Morbidity estimates are supported by data from other sources researched in this report.

Landrigan and Markowitz also deal with the costs associated with the occupational disease incidents. The total for direct medical costs, indirect costs resulting from lost production, foregone opportunities and diminished investments, and non-economic costs resulting from pain and suffering, and disrupted careers, have been estimated. These amount to $600 Million (U.S. 1985 dollars) annually for the five disease categories mentioned earlier. Our estimates rely on data obtained from the Health Economics and Statistics Branch of Alberta Health (see Appendix B).

D. Studies on the Valuation of Life and Long-term Consequences

Approaches to this area of costing can be divided into three separate categories.

The first of these is the wage-loss method, or what is more popularly known as the Human Capital (HK) approach. This approach assumes a present value of future earnings from the time of death or permanent disabling injury. Variations of the same approach consider gross or net values. The net value computations take into account the future consumption by the victim. Over 250 different analytical techniques are available in this area. A number of these are used in estimating pension settlements for victims of accidents.

One publication by Miller, Hoskins and Yalung-Mathews (1987) provides tables for wage-losses for deaths and permanent disabilities by class of accidents and by age-group for the U.S., based on 1986 data. The temporary disability costs are estimated using an 'injury to death' ratio. A discount rate of 6% was used to

determine the present values. For work-related deaths or permanent disabilities the gross wage-loss values are : $619,000 for a male between the ages of 15-24, $1.529 million between the ages of 25 - 44, and $392,000 for the age-group 45 - 64. The choice of the discount rate, and the rate of increase in productivity, are among the major factors which affect the estimates between researchers.

The second approach is based on the analyses of a "willingness to pay" (WTP) to avoid a risk. This approach is premised on the 'pareto optimum' condition which holds that individuals who gain from a social change are willing to compensate those who stand to lose from that change. This is distinct from the method used for determining awards according to the principles of the law of Tort, which is closer to the HK approach. The valuation is directed at a statistical life rather than an identified individual life, i.e., at the value of a specified reduction in the probability of death or disability for a given population. The analyses are based on the studies of 'revealed preferences' within a society as determined by implicit valuations of life placed by societal choices on risk reduction. Society is only willing to pay so much to avoid a certain risk. This method has been used for assessing the cost benefits of risk reduction, especially for legislative programs in the U.S.

A number of published studies using the WTP method are available. Thaler and Rosen (1973) published a methodology based on evidence from the U.S. labour market in which the cost of a life has been estimated at $260,000. Other researchers such as, Viscusi in 1978, Smith in 1976 and Olson in 1981 (all cited in Thaler and Rosen, 1973) have provided estimates based on similar methods. One U.K. study by Melinek (1975) estimated the value of life to be approximately 50,000 British pounds.

The third, and possibly, the most recent method emerging on the scene is proposed by Landefeld and Seskin (1982). This combines the two approaches to determine the discount factor and uses after-tax wages as being representative of the expectations of earnings. The paper discusses the relative merits of the other two methods and offers a table of estimates for the year 1977. The table presents values ranging from a high of $976,304 for a male 20 - 24 years of age to a low of $2,039 for a male aged 85 or over. Comparable numbers for a female varies between $626,792 to $9,966.

The composite assessments of costs described earlier include some or part of the valuations established through these methods. Even though the two methods appear to provide estimates for the same item, the HK and the WTP methods tend to measure two separate costs. The HK approach in measuring the lost earnings reflects a loss of the economic product, or the wealth of the society. It should, perhaps, be compared with the costs of measures such as for increasing the birth-rates, or eliminating immigration

barriers. Some break-even analyses is inevitable as increasing the labour force beyond a certain level also reduces the GNP per capita, a measure of well-being in our societies. However so, this is a 'resource' cost, and is included, in principle, within the accounting for pension payments to the victims or their dependents. Some under-estimating is inevitable as no pension payments are made in the cases of victims without dependents.

The WTP approach, on the other hand, provides a measure for the 'intangible value' that society places on life or a disability. This is not based on the value of lost output, or consumption, but merely provides a societal assessment of the subjective elements associated with an injury or illness risk. This may be assumed as a measure for the 'social' costs, including those for pain, grief or suffering.

A combination of the two methods, as proposed by Landefeld and Seskin (1982), does not provide a more accurate figure, but only one of the two parts. Although data are not available for Alberta, the subjective component using this approach has been included in our assessment of the costs. This is a difficult area to estimate. However, the approach provides an allowance for this element.

E. Cost-studies on Specific Injuries or Illnesses

Literature in this area proved to be of marginal value to the subject under our consideration. A number of estimates are available, including some in Canada, for specific types of illnesses or injuries. Because of the specific nature of these estimates, and the lack of a universally applicable methodology, these costs have not been used in our estimates. Nevertheless, a selection has been included in the bibliography as secondary references.

One study in Alberta by Alleyne, Dufresne, Kanji, and Reesal (1989) estimates the costs of compensation cases due to hearing losses at Cdn. $5.3 million during 1987 in payment commitments. Hearing loss is also the subject of another study by Berger (1985) in the U.S., who estimates compensation costs for this category of impairment as U.S. $3.4 billion over the 10 years from 1984 to 1993.

Other studies in the area cover the asbestos case for an employer (Dewees, 1986), and the costs of spinal injuries (including non-occupational) by the University of Alberta - Faculty of Medicine (1989). Some assessments are also available for the compensation costs of back injuries. One estimate for an industry sector provided by Gibbs and Pintus (1978) quote costs of accidents in the Canadian Mining industry as between $25 and $32 million for the year 1970.

Cost estimates have been quoted in the news media and magazines for stress-related illnesses, drug-use in the workplace and a variety of other maladies. The source and validity of such figures are uncertain.

F. Cost-benefit Studies of Programs

As the heading implies, these studies generally contain analyses, or record of actual or projected effectiveness of health and safety programs. A number of the papers also propose methodologies or principles for use in determining the cost benefits.

Numerous papers are available which describe cases of single experience within companies. The majority are by practising health and safety professionals recording their own experiences. The methods for determining cost-savings vary per individual assumptions and cost accounting practices. One by Cochran (1978) discusses the case for a mining company reducing its accident rate by 60% through a program costing $200,000 per year. A program directed at reducing repetitive strain injuries in a manufacturing plant in Alberta, saved the company $95,200 per year while reducing these injuries from an annual total of 20 to 4 (1989). A skin protection program described in a journal (Hombach, 1984) compares the cost of protection at $1.00 per month per employee with the costs for occupational dermatitis at $1,500 per month. Schramm (1977) illustrates the cost savings to be obtained through a multi-employer program directed at treatment of alcoholism among workers.

A few of the papers in this category represent studies conducted on a broader base. Rinefort (1985) describes a Cost Benefit Analysis (CBA) conducted in 140 Texas chemical, paper and wood manufacturing firms, with statistical analyses of data to identify the most cost-effective elements in a health and safety program. A research thesis published in France in the building and construction industry and quoted by Andreoni (p. 36, 1986) recorded a productivity gain of 5% in the main construction work through the implementation of a safety program. More recently, studies have been conducted by consulting organizations to validate improvements in productivity and absenteeism rates through the establishment of Employee Assistance Programs (EAP). Similar data are available through other sources such as the International Loss Control Institute (ILCI) and the Safety Services Division of the E.I. Du Pont de Nemours. In the majority of instances, such data are not obtained through controlled research methods which are difficult to conduct in the area. However, the benefits from a health and safety program have never been disputed on record.

These benefits represent the credit side of the total costs of occupational injuries and illnesses. Therefore, in the strictest analytical approaches, these amounts deserve to be accounted for within the total costs. However, since our estimates do not include the fixed costs of prevention e.g., the costs of the health and safety programs, the credit amounts have also been discarded for our purposes.

Several papers in this category also offer methodologies related to the economics of safety, including some which provide the format for Economic Impact Statements (EIS), or models for formal cost-benefit analyses. The Government of Canada's administrative policy provides for an approach to Socio-Economic Impact Analysis (SEIA). One such analysis (Labour Canada, 1985) conducted for the legislation on WHMIS (Worksite Hazardous Materials Information System) estimated a cost benefit of $1.33 billion for the year 2024 in present value terms. In the interests of brevity, these are not discussed here. However, a representative number is presented in the annotated bibliography as secondary references (see the Annotated Bibliography 1, 5, 9, 13, 14, 16, 27, 45).

(IV) METHODOLOGY, RESULTS AND DISCUSSIONS

The study has been limited to estimates for the consequential costs of occupational illnesses and injuries. These are the resource or opportunity costs which may be assigned to alternate purposes.

An underlying assumption is that the 'alternate purposes' to which the resource may be applied are freely available. In other words, the marginal utility of the transferable dollar is assumed.

Cost computations are based on a variety of discrete models. These include mathematical, statistical and empirical methods. The selection of these individual methodologies is, of necessity, biased towards their compatibility with existing data.

The costs are assigned to the cost-centres according to the principles of workers' compensation, and on the basis of current accrual of liabilities. As far as possible, the value of the resource is measured in transferable dollars, as the actual 'pay-out' or 'loss' to a cost-centre.

The three major cost centres adopted in our model are:

A. Cost to Industry (C_i);

B. Cost to the Government, the Intermediate Agencies and the society (C_g);

C. Cost to the Worker (C_w).

Within these major cost-centres a number of secondary cost-centres have been established. The total cost is the summation of all the elements and is provided in Table 24 on page 41. The values of the variables for each of the three years (1986, 1987, and 1988) are listed in Appendix B.

Discussions of the results and the assumptions for each of the cost-centres are provided at the end of each section.

A. Cost to the Industry (C_I)

For this cost-centre,

$$C_I = (C_{LTC} + C_{MINOR} + C_B + C_M + C_{PV} + P) + C_{uninsured}$$

where,

C_I	=	the total cost attributed to all industry;
C_{LTC}	=	the costs to the 'insured' sector due to lost-time claims;
C_{MINOR}	=	the costs to the 'insured' sector due to injuries other than those for lost-time claims;
C_B	=	the cost of fringe-benefits to the 'insured' sector;
C_M	=	the cost of material damages;
C_{PV}	=	the variable cost of prevention due to injuries;
P	=	the financial losses to the 'insured' sector due to injuries;
$C_{uninsured}$	=	the cost to the 'uninsured' sector of the industry.

C_{LTC} is defined as the cost representing the following items:

Average uninsured time for injured worker paid by the employer (0.5 x 8 hours per shift).

Average administrative time per supervisor such as for investigation, filling out forms, reassignment of work (estimated at 2 hours per episode).

Absenteeism and work-stoppage supplement due to assistance to victim, transportation hours, interruptions/inefficiencies, replacement of worker and retraining etc., are estimated at 25% (Ginpil, 1987 and Laufer, 1987) and 12.5% of the average number of compensation hours lost by the victim for the two categories of injuries mentioned below. The indirect labour units accounted for do not include the cost of benefits, which are estimated separately. The average number of compensated hours are established on the basis of a standard shift of 8 hours for the average number of compensation days per claim cited in the WCB Annual Reports (1986, 1987, and 1988).

The lost time injuries derived from the WCB Claims records by Alberta Occupational Health & Safety (AOHS) Claims Summary (1987, 1988), have been categorized in two separate groups according to the nature of injuries. The first category consisting of the types of injuries assumed to result in a greater proportion of hours (25% of the average compensation hours per victim) lost to the employer, are:

50% of the total number of sprains and strains
Cuts and Lacerations
Scratches and abrasions
Multiple Injuries
Bruises and Crushes
Dislocations and Fractures
Burns and Scalds
Chemical Burns

The second group consists of the types of injuries which are assumed to result in lost labour units amounting to 12.5% of the average compensation hours, i.e., half of the estimated labour units lost in the previous category. These are:

Remaining 50% of the sprains and the strains
Bursitis, Synovitis
Injuries listed as 'Other injury'
Diseases listed as 'Other disease'
Radiation

The claims listed as 'non-personal damage' in the AOHS report have not been included in either category.

All direct and indirect labour units are computed for each category of injuries. For the first set of injuries, a total of 116, 108, and 112 manhours for 1986, 1987 and 1988 respectively are attributed. Sixty-one, 57, and 59 hours are estimated for the second category for the same three years. The upper end estimate for a specific year is based on the number of manhours for the first set of injuries. For example, 108 hours for all injuries serve as the upper end estimate for 1987.

In the following table, the costs have been computed according to the formulas below.

$C_{LTC} = W \times [(0.25 \times 8 \times Days_C + 4 + 2) \times N_1] + W \times [(0.125 \times 8 \times Days_C + 4 + 2) \times N_2]$
where,

W	=	Average gross industrial wage per hour,
$Days_C$	=	Average Compensation days per claim,
N_1	=	Number of claims in first category,
N_2	=	Number of claims in second category.

The upper estimate is based on :

$C_{LTC} = W \times [(0.25 \times 8 \times Days_C \times N) + 4 + 2]$

N being the total number of claims ($N_1 + N_2$).

Table 1

Costs of lost labour units to the 'Insured' Sector Due to Lost-time Claims

C_{LTC}	1986	1987	1988
Lower estimate	56.2M	50.9M	57.6M
Upper estimate	62.3M	56.3M	64.0M

Costs of in-house drugs and medicine (considered to be small), and ambulance costs (in a small proportion of the cases amounting to $153 approximately per trip in 1989) are assumed to be accounted for within these estimates. Separate allowance has not been made for costs of legal fees, labour units for clean-up, which in the context of the total estimates, is negligible and according to the studies done by Brody et al (1989), occurs in 1 to 2% of the incidents which result in up to 60 lost-days.

Separate allowance has also not been made for the cases of fatalities or permanent disabilities. The fatalities within the compensation system number approximately 100 to 125 cases per year, of which the majority are highway deaths. Approximately 45 - 50 are investigated annually by the AOHS. A very small proportion of these and other cases involve legal and other expenses on the part of the employer. When seen in the context of the nearly 43,000 lost time claims per year, the costs of these are insignificant, even if some individual instances may be disproportionately high.

The numbers for lost time claims include those for longer term disabilities, which would tend to inflate the average number of compensated hours, and produce a corresponding bias in both of these estimates.

C_{Minor} is defined as the cost of injuries not resulting in a lost time claim, i.e., injuries with less than a day in lost time.

The number of such injuries may be estimated through the use of either Bird's ratio of 10, or the adjusted British Safety Council (BSC) ratio of 12.5 (cited in Andreoni, 1986) as applied to the Lost Time Claim records.

For the cost per episode, two estimates have been provided. The upper estimate is based on Simonds' estimate of $30 (1975, U.S. dollars) modified to an all inclusive cost of $40, as adjusted for inflation and Canadian medical costs. The lower estimate is assigned the average hours lost by a victim during the day (i.e. 4 hours) plus an allowance of 0.5 hours for the supervisor.

The lower and upper estimates are calculated as follows:

C_{Minor} (Low estimate) = $40 x 10 x N
C_{Minor} (Upper estimate) = W x [(4 + 0.5) hours x 12.5 x N]

Table 2

The Costs to the Insured Sector Due to 'Minor' Injuries

C_{Minor}	1986	1987	1988
Lower estimate	17.2M	16.7M	17.6M
Upper estimate	31.9M	31.1M	34.0M

The ratios used to arrive at the number of minor injuries were derived in the 1970s. Progress in preventive efforts, the nature of industries in Alberta and their hazards are among factors which will affect these ratios, and therefore, the estimates.

The 4 hour allowance has been assumed to cover the inefficiencies due to the temporary absences from the job. The vast majority of these cases do not result in absence from work for the rest of the day.

C_B is defined as the cost of fringe benefits borne by the employer while the victim is on compensation. The cost is due to the direct labour units lost by the victim as well as the labour units lost by other employees.

This is applicable to a fraction of the work-force (35%). This fraction is estimated from the Statistics Canada report on Work Absences and Compensation (as a supplement to Statistics Canada, Catalogue: 71-001, 1986), which provides data on workers receiving benefits from employers while absent for over two weeks.

Benefits are assumed to average at 20% of gross wages. In this case, the higher wages to salaried workers (Statistics Canada Catalogue: 71-001 -Supplement "Work Absences and Compensation, 1979-86) have been used. The ratio of employees receiving benefits is applied to the total number of days compensated by the WCB for claims during the current year (WCB Annual Reports, 1986, 1987, 1988). The ratio (35%) (Statistics Canada 71-001 Supplement, 1986) is applied to the indirect labour units computed for the costs C_{LTC} and C_{MINOR}.

C_B is calculated as follows:

$$C_B = 0.2W_s \times 0.35 \times \text{Total Compensation days} \times 8$$
$$+ 0.2W_s \times 0.35 \times [(0.25 \times 8 \times \text{Days}_C + 4 + 2) \times N1]$$
$$+ 0.2W_s \times 0.35 \times [(0.125 \times 8 \times \text{Days}_C + 4 + 2) \times N_2]$$
$$+ 0.2W_s \times 0.35 \times [(4 + 0.5) \text{ hours} \times 12.5 \times N]$$

where,

W_s = Average hourly wage for salaried workers.

Table 3

Cost of Benefits to the 'Insured' Sector

	1986	1987	1988
C_B	15.1M	13.7M	15.4M

The Quebec study by Brody et al (1989) cites fringe benefit payments occurring during 96% of the cases and accounting for 47% of the total indirect costs. This has not been used in our computations.

The population ratio between those receiving benefits and those who do not, has been applied to arrive at the proportions of compensated days between these populations. This assumes that the nature of injuries and risks are equal between the two groups.

The benefits received by workers through private insurance schemes are included in these costs. Normally these insurance payments where available supplement compensation payments up to a specified maximum. We have assumed that the payments made equal the cost of premiums which are included in the total cost of benefits (20% of gross wages).

C_M is defined as the cost of material or property damages incurred in an injury incident.

We have used the results obtained through a German study for the year 1972, quoted by Andreoni (p. 127, 1986). This estimates that 7% of occupational injury incidents are accompanied by material damage and that the costs of damage amount to approximately 16% of the total costs of occupational injuries to the employers. Generally, these costs include only in-plant costs due to losses to production materials.

A separate component has been included for the material cost of motor vehicle accidents which are compensated by the WCB. Damages to motor vehicles are customarily covered by separate accounts. Data obtained from the Insurance Bureau of Canada show the average cost of settlement of vehicle claims to be approximately $2,000. All single and multiple vehicle accidents accounted for within the WCB system number 971, 948, and 979 for the three respective years.

The costs in the table are computed as follows:

$$C_M = [(0.07 \times 0.16)/(1 - 0.07 \times 0.16)] \times (C_{LTC} + C_{MINOR} + C_B + C_{PV} + P) + \$2{,}000 \times n$$

where n = total number of single and multiple vehicle accidents among the number of claims compensated by the WCB.

The upper and lower estimates are derived from the use of corresponding values for each of the component costs.

Table 4

Cost of Material Damage

C_M	1986	1987	1988
Low estimate	3.0M	2.9M	3.1M
Upper estimate	3.2M	3.1M	3.3M

These estimates compare with figures available from Business Insurance Agencies (Insurance Bureau of Canada - computer printouts, 1989) which show the total cost of all business related claims due to material loss, regardless of injury or non-injury, to be $49 million and $59 million for the years 1985 and 1986, respectively, in Alberta. The corresponding figure for 1987, the year of the tornado in Edmonton, is $76 million. The average costs of a claim are $4,354 and $4,405, respectively for the first two years. These costs do not include amounts lost under self-insurance.

Also of note are the findings of the Quebec study by Brody et al (1989) which cites 2% of the uninsured costs as being the costs of the repairs, clean-up and damage to merchandise, and occurring in 1 - 5% of the cases.

C_{PV} is defined as the variable expenditure on prevention by employers. These costs may be incurred by individual employers or by employer organizations. Typically these may be due to special safety meetings, health examinations, bulletins, memos to staff, training sessions, research studies, design and procedural changes, etc. All of these are precipitated by discrete events, and are of extraordinary nature being above and beyond the scope of normal prevention activities.

An estimate allowance only of $1 million, for each of the three years, has been made for this cost centre.

A notable example from the Albertan scene is the recent effort by the Upstream Petroleum Industry Taskforce of Safety (UPITFOS) as a direct result of the high number of injuries in this sector. Such effort is not uncommon among individual companies although cost data on such campaigns are not available.

P is defined as the financial loss to the 'insured' sector of the Alberta industry, associated with the lost production due to an injury. This is not the total value of production lost, but the loss in contribution to the profits due to the loss in production.

P is the loss associated with the labour units lost by the victim on the first day until he/she has been replaced, and with all subsequent units lost by the other employees. These labour units have been calculated under C_{LTC} and C_{Minor}.

Value of production (= sales) per worker is computed from the published data on Gross Domestic Product (GDP) at factor cost for Alberta (Alberta Bureau of Statistics - 1988 Preliminary Estimate of GDP, 1989), and the number of workers (1,182,000 assumed constant over the three years under consideration). The average pre-tax profit (5%) on sales for Alberta Corporations, is obtained from Statistics Canada Catalogue 61 -207 (1987).

A single estimate, using the upper end estimates in the other cost-centres, has been provided. The computations are done using the following :

P = 0.05 x GDP per worker per hour x Total number of labour units lost directly and indirectly,

where,

Total number of labour units lost directly and indirectly are computed in the calculations for C_{LTC} and C_{Minor}, and is equal to:

$$[(0.25 \times 8 \times Days_C + 4 + 2) \times N] + [(4 + 0.5) \text{ hours} \times 12.5 \times N]$$

Table 5

Financial Losses to the 'Insured' Sector

	1986	1987	1988
P	9.9M	9.3M	11M

These amounts do not include the proportion of dividends as only pre-tax profits are considered.

The methodology is consistent with that used for productivity measures (Statistics Canada Catalogue 15-204, 1987). We have also assumed that an injured worker is replaced on the day following the injury. The cost of replacement is accounted for separately within cost-centre C_{LTC}.

$C_{Iuninsured}$ is the pro-rated cost assigned to the 'uninsured' non-WCB sector of the industry.

This is based on the relative proportions (1:3) of the work-force.

$C_{Iuninsured}$ is estimated as :

$$0.33 \times (C_{LTC} + C_{MINOR} + C_B + C_M + C_{PV} + P)$$

Table 6

The Cost to the "Uninsured" Sector of Industry

	1986	1987	1988
$C_{Iuninsured}$	42.6M	39.4M	44.0M

There are some limitations to our simplifying assumption that the conditions are equal in both sectors. The distribution of risks among this sector of employers varies from that in the larger population. The employers outside of the compensation system in the service and the finance sectors have low risks, while those in the agriculture sector are subject to high risks.

The costs have been pro-rated based on the total cost incurred by the 'insured' sectors. This may result in an upper end bias in the costs to industry, since costs to these employers are probably restricted to the elements C_{LTC}, C_M and P only. The costs resulting to the other major cost-centres, such as the worker and the government, are on the other hand likely to be higher than proportional.

An alternate approach may be used based on the total man-hours lost and value-added. However, although lost man-hours have been computed at 2,888,000 latter in this report, value-added estimates are unavailable for these sectors of the economy.

The following general comments are offered in respect of the methodologies used for the Costs to Industry.

We have assumed that Alberta is a market-driven economy and all production is converted into sales. Correction factors such as those based on capacity utilization, or the elasticity of the labour market variables, have not been used. This assumption is basic to the establishment of this cost-centre. However, in the vast majority of the injury/illness incidents, no long-term loss in sales occurs as production is made up eventually. The few exceptions are, of course, the cases where say, a contractor is unable to complete or accept jobs as a result of injury to a skilled worker, or when a smaller employer loses orders to a competitor resulting in irrecoverable loss in sales. An underlying assumption is also that in a period when sales are limited by capacity to produce, a reduction in injuries produce a corresponding increase in output. This is rarely the case, since at a work-site other factors such as availability of materials or equipment would prevail. The injury does not normally result in lost production, but possibly in an increase in the cost of production, through overtime or other such determinants. Preliminary results from the study by Brody et al (1989) indicate that the costs of lost production or overtime etc., occur in about 10% of the incidents, administrative costs and wage-losses for other employees occur in 14 - 15 % of the incidents. The outlay for fringe-benefits occurs more frequently at 47% of the cases.

Size of the company or 'production unit' may be an important variable in determining the validity of this assumption. The larger companies will likely have a greater proportion of lost labour units and higher cost of benefits. The smaller employers will probably incur higher financial losses associated with lost production or sales.

Our project is directed at estimating the 'resource' cost. The cost of consequential labour units not utilized in 'productive work' has been assumed to have a value available for 'alternate purposes'. The estimate for material damages represent a 'true loss' and has been corrected for the frequency of occurrence. An estimate based on 'economic costs' will likely reduce the estimates attributed to this cost-centre.

As stated earlier, the fixed costs of prevention are not included. These include the costs due to a Health and Safety Department, the costs of protective equipment provided to workers, or the costs for incorporating equipment and process features which result in enhanced protection to workers.

Expenditure on WCB insurance premiums is not included in this cost-centre. This is represented through the cost of claims, and transferred to the cost-centre C_6. Even while industry pays for the insurance premiums, the administration and the ultimate liability fall within the scope of the government.

The variable portion of the WCB insurance, i.e., the additional assessments due to a poor record, or a discrete incident such as a fatality, is not included since this amount is assumed to be at least equal to the benefits paid out and accounted for within the claims costs. Normally, approximately 18% of the claim costs are covered through the experience rating system in Alberta WCB.

No additional cost has been attributed to this centre in respect of unreported cases of occupational diseases.

Table 7

Estimates for the Costs to Industry

(Figures are in millions of Canadian Dollars)

	1986		1987		1988	
Description	WCB	Non-WCB	WCB	Non-WCB	WCB	Non-WCB
C_I		42.6		39.4		44.0
C_{LTC} - Lost-time Injuries	62.3 (*56.2)		56.3 (*50.9)		64.0 (*57.6)	
C_{MINOR} - Minor Injuries	31.9 (*17.2)		31.1 (*16.7)		34.0 (*17.6)	
C_B - Benefits	15.1		13.7		15.4	
C_M - Material Equipment Damage	3.2 (*3.0)		3.1 (*2.9)		3.3 (*3.1)	
C_{PV} - Variable Expenditure on Prevention	1.0		1.0		1.0	
P - Output Loss	9.9		9.5		11.0	
SUB-TOTAL	123.4 (*102.4)	42.6	114.7 (*94.7)	39.4	128.7 (*105.7)	44.0
TOTAL: C_I	**166.0 (*145.0)**		**154.1 (*134.1)**		**172.7 (*149.7)**	

Notes: Figures in parentheses with an asterisk denote the lower estimates.

B. Cost to the Government, the Intermediate Agencies and the Society (C_G)

Several secondary components are considered within this single major cost-centre. Some of these capture the more visible components such as costs of the WCB, revenue losses, variable costs for prevention within the government. Others are less visible in nature, such as the general Health Care costs due to occupational diseases, for injuries and illnesses of the uninsured workers, costs to the Unemployment Insurance programs due to the 'uninsured', and finally, the long term consequential costs due to fatalities.

For this cost centre,

$$C_G = C_{WCB} + C_R + C_{PREVENTION} + C_{AHC} + C_{UIC} + C_{LONGTERM}$$

where,

C_G	=	the total cost attributed to government and all agencies;
C_{WCB}	=	the costs of consequential nature incurred by the WCB;
C_R	=	the costs due to lost revenues to the provincial and federal governments;
$C_{PREVENTION}$	=	the variable costs of prevention borne by the government due to illnesses and injuries;
C_{AHC}	=	the costs accruing to Alberta Health;
C_{UIC}	=	the cost of unemployment insurance payments to the 24% of the 'uninsured' workforce;
$C_{LONGTERM}$	=	the long-term costs due to mortalities.

C_{WCB} is the centre for costs of consequential nature within the workers' compensation system.

The following components of the WCB costs are considered to be consequential in nature, and are obtained from the published Annual Reports (1986, 1987, 1988).

Table 8

WCB costs

	1986	1987 ($ Thousands)	1988
Paid to the workers:			
Compensation	135,198	117,454	124,406
Pension awards	120,707	113,384	118,972
Vocational Rehabilitation programs	12,592	15,408	15,833
Treatment costs:			
Worker rehabilitation	6,324	6,327	6,456
AHC* payments for direct billings	11,546	12,631	13,182
Medical costs for Hospitals, Drugs & Prosthesis as paid to the provider	31,989	30,945	32,690
Total	318,356	296,149	311,539

(* Alberta Health Care)

The compensation system covers some 876,000 workers representing 74.1% of the total workforce. Pension awards are for fatalities and for permanent disabilities. Compensation costs consist of direct payments to the victims for temporary disabilities. The dates for opening the claims for pensions and permanent disabilities lead to some confusion in the interpretations of the data. However, these are not considered to be significant in the context of our total estimates over the three years.

These costs do not include those incurred by the 'self-insured'. The Government of Canada, for example, is in this category.

Administration and operating costs, and prevention related expenditures such as transfers to Alberta Occupational Health and Safety through the general revenues, research grants, and grants towards Safety Associations have not been included in our estimates.

Claim costs only have been included as being the amounts actually paid out during a year. An alternative approach may be based on the use of 'full-funded' costs. These include provisions for future year payments for the claims received during a given year. Such an approach will increase the estimates by $23 million, $39.8 million and $29.8 million for 1986, '87 and '88 respectively.

$C_{Revenue}$ is the cost-centre devised to capture the costs due to lost revenues to the provincial and the federal governments. No distinction is made at this time between the jurisdictions. Worker wage-losses within cost-centre C_W later in the report, have been computed net of tax.

$$C_{Revenue} = C_{R1} + C_{R2} + C_{R3} + C_{R4} + C_{R5}$$

These sub-elements are defined as follows:

C_{R1} = revenue losses associated with the WCB payments;

C_{R2} = revenue losses associated with the reduced earnings by the worker;

C_{R3} = revenue losses associated with the financial loss component P of C_I (Cost to Industry);

C_{R4} = revenue losses due to the costs of occupational disease mortalities; and

C_{R5} = revenue losses due to injuries to the 24% of the 'uninsured' section of the workforce.

(C_{R1}) Revenue losses associated with the WCB payments which are not taxable, are computed at an assumed average tax rate of 10% for the combined total of the compensation and the pension payments.

This sub-element is computed as:

$$C_{R1} = 0.10 \times (\text{Compensation costs} + \text{Pension awards})$$

Table 9

Revenue Losses due to non-taxable claim payments

1986	1987	1988
25.6M	23.1M	24.3M

(C_{R2}) Revenue losses associated with the reduced earnings by the worker are based on the assumption that compensation and pension payments average at 90% and 50% of full earnings entitlements. The average tax rate of 10% is assumed also in this case.

C_{R2} = 0.10 x [(compensation payments X 0.10) + (pension payments X 0.50)]

Table 10

Revenue Losses due to Reduced Earnings

1986	1987	1988
7.4M	6.8M	7.2M

(C_{R3}) Revenue losses associated with the component **P** (Table 5 : Consequential Financial Losses) of Cost to Industry, have been calculated at an average 26 % taxation rate on pre-tax profits of medium corporations of the corporate income (Statistics Canada Catalogue: 61-207, 1986).

C_{R3} = 0.26 X P

Table 11

Revenue Losses due to Financial Losses to Industry

1986	1987	1988
2.6M	2.5M	2.9M

(C_{R4}) Revenue losses due to the costs of occupational disease mortalities, estimated elsewhere at 276 per year (Appendix 'C'), have been calculated, simplistically, at $240,000 (assumed for an average victim 55 - 59 years old) wage-loss per year at an average tax rate of 10%. These mortalities are not accounted for in the WCB figures.

Table 12

Revenue Losses Due to the Costs of Occupational Disease Mortalities

1986	1987	1988
6.6M	6.6M	6.6M

(C_{RS}) Revenue losses due to injuries to the 'uninsured' 24 % of the work force is estimated on the assumption that in this category an injured worker loses his/her total wage.

The distribution of the approximately 273,000 members in the 'uninsured' workforce is estimated to be 133,000 in the Service sector, 88,000 and 52,000 in the Agriculture and the Finance sectors respectively. (Source: Alberta Occupational Health & Safety - Research and Information Development). The direct manhours lost are estimated at 2,888,000 manhours for 1987. We have used lost time injury rates of 8.0 for agriculture, 4.0 for the service and the finance sectors from comparable sectors within the WCB. These compute at 14,440 lost time incidents which 25 days lost per injury in comparable WCB sectors yield 2,888,000 manhours for 1987. Using the average wage and an average tax rate of 10%, the costs are provided below. The same number of manhours has been applied for all three years. Losses arising out of fatalities among these workers have not been included in this cost-element.

This revenue loss is computed as:

$C_{RS} = 0.10 \times [2{,}888{,}000 \times W_H]$,

where, W_H = Average hourly wage rate (see Appendix A)

Table 13

Revenue Losses Due to Injuries to the 'Uninsured' Workforce

1986	1987	1988
3.1M	3.1M	3.2M

$C_{Prevention}$ is the variable component of prevention costs borne by the government due to illnesses and injuries.

Conservatively, this is estimated to be the equivalent of 40 manyears. The estimates include the cost of salaries, benefits and other resources.

Table 14

Cost of Prevention Measures Due to Illnesses and Injuries

1986	1987	1988
2.4M	2.4M	2.4M

A proportion of the administrative and other costs incurred by the WCB, may be assigned to this centre. This has not been included.

Assumption is that this amount of resource may be utilized for true prevention measures if not expended as at present. These include investigations and reports, activities such as the Significant Incident Review Boards, information dissemination related to all types of incidents including fatalities. Besides Alberta Occupational Health and Safety, other departments such as the Medical Examiners' Office, the Energy Resources Conservation Board, Alberta Labour, Alberta Social Services and other agencies are also involved in these consequential activities.

C_{AHC} is the centre where the 'non-visible' costs accruing to Alberta Health are allocated. These costs are separate from those reimbursed by the WCB for services provided within the health care system for reported compensation cases. Two major additive components have been accounted for.

(C_{AHCi}) Costs associated with the treatment of the 'uninsured' victims have been estimated at the same average WCB cost per claim in this area. Worker rehabilitation costs have not been considered. The method for arriving at the number of injuries has been described earlier for cost-centre C_{FB}.

The costs are computed as:

C_{AHCi} = [(AHC payments + Medical costs)/N] x 14,440

Table 15

Cost of Treatment of the 'Uninsured' Workers

1986	1987	1988
14.5M	15.1M	15.0M

(C_{AHCdis}) Costs of the estimated numbers of occupational diseases in limited and specific categories, have been determined, on a preliminary basis, using data provided by Alberta Health (Appendix 'C').

Estimates for the numbers of mortalities in these categories, such as cancers, chronic respiratory disease, cardio-vascular disease, renal and neurological disorders have been made based on available literature discussed in Section 2 of this report. All cases cited for Pneumoconiosis are attributed to this cost-centre. Costs are computed using the ratios, the number of total hospital separations, average lengths of stay, cost per patient day, the fees due to ambulatory services and for procedures. The detailed computations are provided in Appendix 'C'. Extrapolation was necessary to arrive at the Hospital Care costs for 1988.

Table 16

Costs of Selected Occupational Diseases

	1986	1987	1988
Hospital Care	12.9M	13.8M	14.0M
Fees for			
Ambulatory Care*	8.5M	9.4M	9.6M
Procedures*	9.3M	10.6M	10.7M
Total	30.8M	33.8M	34.3M

Numbers of discrete pneumoconiosis patients provided by Alberta Health appeared to be unusually high in our opinion. However, these numbers have been retained at this time until new analyses are possible.

Additional costs may be attributed to this centre due to mis-directed billings by medical practitioners and due to higher than average cost of medical expenses incurred by past victims of workplace accidents. Data are not available in these areas.

C_{UIC} provides the estimates for Unemployment Insurance payments to the 24 % of the workforce not covered by the WCB, who are assumed to receive such payments if their absences due to injury exceed the waiting period.

Costs of these payments are estimated through the use of estimated manhours lost (2,888,000) in this sector and applying the percentage (14.1%) of all absentees who are reported to be on UI multiplied by the average payment per week (Statistics Canada Catalogue: 73-001, 1988).
The costs are estimated as:

C_{UIC} = [2,888,000/40] x 0.141 x Average UI payment

Table 17

Cost of the UI Payments to the 'Uninsured' Workforce

1986	1987	1988
2.0M	2.0M	2.1M

The Statistics Canada report deals only with cases of absences more than two weeks. A proportion of the 'uninsured' population also consists of the self-employed who do not normally subscribe to the Unemployment Insurance program, and therefore, are not eligible. No correction has been made for this population. The unemployment insurance costs may also be regarded as longer-term production losses.

$C_{Long\text{-}term}$ is an estimate for the long-term resource costs associated with the additional number of mortalities estimated. These are the consequential costs to the society, not accounted for elsewhere, due to loss of life.

These residual long-term costs have been estimated at the earlier quoted (cost-centre C_{R4}) gross wage-loss of $240,000 present value per year per mortality for the 276 mortalities due to the unreported cases of occupational diseases. The costs are net of the revenue losses to the government, which are accounted for within sub-element C_{R4}.

$C_{Longterm}$ = 276 x $240,000 x (1 - 0.10)

Table 18

Long-term Consequential Costs

1986	1987	1988
60M	60M	60M

Costs associated with losses in quality of life are not the subject of this cost-centre. These have been defined as the subjective elements and accounted for separately.

Costs in this category which are associated with the illnesses and injuries during the life-time of a worker, are not included on the assumption that these have been fully compensated for within the WCB and the Unemployment Insurance programs.

The number of fatalities processed through the WCB system, have not been included on the assumption that the pension awards by the WCB accounts for such costs of wage-loss or loss of economic product.

WCB, does not award pensions to fatal victims without dependents. Also, fatalities within the 'uninsured' sector due to traumatic causes are not included. These tend to produce a low-end bias in the total estimate.

The costs to the government due to all sub-elements are summarized in the table on the following page.

Table 19

Estimates for the Costs to Government

(Figures are in millions of Canadian Dollars)

Description	1986 WCB/Common/Non-WCB			1987 WCB/Common/Non-WCB			1988 WCB/Common/Non-WCB		
C_{WCB} - WCB	318.4			296.2			311.5		
C_{R1} - Compensation & Pension Payments	25.6			23.1			24.3		
C_{R2} - Reduced Earnings	7.4			6.8			7.2		
C_{R3} - From Cost Factor "P"	2.6			2.5			2.9		
C_{R4} - Occupational Disease Mortality		6.6			6.6			6.6	
C_{RS} - Uninsured Population			3.1			3.1			3.2
$C_{Prevention}$ - Prevention Measures		2.4			2.4			2.4	
C_{AHCi} - Treatment for the Uninsured Workforce			14.5			15.1			15.0
C_{AHCdis} - Occupational Diseases		30.8			33.8			34.3	
C_{UIC} - UI			2.0			2.0			2.1
$C_{LONGTERM}$ - Longterm Consequential Costs	60.0			60.0			60.0		
SUBTOTAL	354.0	99.8	19.6	328.6	102.8	20.2	345.9	103.3	20.3
TOTALS: C_G		473.4			451.6			469.5	

C. Costs to the Worker (C_W)

C_W represents the residual costs which are assumed to be borne by the injured or, the ill worker. The costs are estimated separately for actual monetary loss and for the subjective elements. These are computed net of tax which has been accounted for within C_R.

(C_{Wins}) Actual earnings loss to the 'insured' population of the workforce, are estimated from the fact that the WCB compensation entitlement is for 90% of net earnings (after tax) for temporary disabilities and, for permanent disabilities, pension awards are for 50% of full entitlement. WCB payments are, however, not taxable, which means a saving to the worker. A net amount has been calculated using the average tax rate of 10%. For the 'insured' workers, the amount is:

$$C_{Wins} = (1 - 0.10) \times [(\text{Total compensation payments} \times 0.10) + (\text{Pension awards} \times 0.50)]$$

Table 20

Cost to the 'Insured' Worker

1986	1987	1988
66.5M	61.6M	64.7M

($C_{Wuninsd}$) For the 'uninsured' workers the calculation is based on the wage-loss net of tax, the UI payments and a pro-rated (1:3) portion of the cost C_B (Cost of Benefits to the employer). The total labour units lost has been calculated as 2,888,000 hours for the sub-element C_{RS}. The amount is computed as follows.

$$C_{Wuninsd} = 0.9 \times 2{,}888{,}000 \times W - C_{UIC} - 0.33 \times C_B$$

Table 21

Costs to the Uninsured Workers

1986	1987	1988
27.2M	27.9M	28.4M

(C_{wsubj}) Subjective costs have been estimated using Landefeld and Seskin's (1982) tables based on the modified WTP approach. The average age was computed using WCB data for the fatalities reported by the WCB (Annual Reports 1986, 1987, 1988) and assumed to be 55 -59 for the unreported cases. In the absence of more recent data, the 1977 estimate (U.S. $380, 400) provided by Landefeld and Seskin has been adjusted for inflation to 1988 (40%).

Table 22

Subjective Costs

	1986	1987	1988
WCB recorded Fatalities	132	101	124
Estimates for additional disease mortalities	276	276	276
Costs @ $532,560 (1988) [Adjusted for inflation (40%) - based on Landefeld & Seskin's $380,400 (1977)]	217M	201M	213M

The costs are presented as cost to the worker since he/she is the most directly affected. These costs are meant to include such items as loss of potential for higher earnings, reduction in quality of life, loss of earnings from private activities and other opportunity costs. These also include the cost of pain, grief, or suffering. While these costs are applicable equally to cases of mortalities and morbidities, only the mortality cases under all accounts have been considered. The marginal benefits, i.e., the difference between the fixed costs borne by the worker, e.g., UI premiums, proportion of taxes paid for selected state and municipal benefits, and the value of benefits received in return have not been considered, since these will only apply to the morbidity cases.

Costs attributable to the worker are presented in Table 23, and the costs due to each of the major cost-centres are presented in Table 24.

Table 23

Estimates for the Costs to Worker and Subjective Costs

(Figures are in millions of Canadian Dollars)

	1986		1987		1988	
Description	WCB	Non-WCB	WCB	Non-WCB	WCB	Non-WCB
C_W - Worker	66.5		61.6		64.7	
$C_{Wuninsured}$ - Uninsured Portion		27.2		27.9		28.4
SUBTOTAL		93.7		89.5		93.1
C_{SUBJ} - Subjective Costs		217.0		201.0		213.0
TOTAL: C_W		**310.7**		**290.5**		**306.1**

Table 24

ESTIMATES FOR THE TOTAL COST OF OCCUPATIONAL INJURIES AND ILLNESSES IN ALBERTA - SUMMARY

(figures are in millions of Canadian Dollars)

Description	1986	1987	1988
C_I - Cost to Industry	166.0	154.1	172.7
	(*145.0)	(*134.1)	(*149.7)
C_G - Cost to Government	473.4	451.6	469.5
C_W - Cost to Worker	310.7	290.5	306.1
C_T - Total Cost	950.1	896.2	948.3
	(*929.1)	(*876.2)	(*925.3)

* denotes the lower estimate for the cost centre.

(V) CONCLUSION AND RECOMMENDATIONS

A. COMPARATIVE RATIOS

As seen from Table 24, the estimate for the total annual cost range from $880 million (M) to $950 million. If the subjective costs assigned to the worker are excluded, this estimate ranges between $680M to $740M.

Some components are noted below

The 'insured' sector of the industry loses between $95M and $130M, through 'indirect' or 'uninsured' costs. For the 65,000 employers this averages at between $1,500 to $2,000 per year per employer.

The 'uninsured' cost to all sectors of the industry has been estimated at between $135M and $170M. The non-WCB sector loses between $40M to $45M.

Direct loss of revenue to the government is estimated at $45M.

Health care costs within Alberta Health are estimated at $45 - 50M, of which $30 - 35M are due to occupationally related diseases.

Workers lose between $90 and $95M in earnings.

The ratio between the 'indirect' and the 'direct' (or the 'uninsured' and the 'insured') cost to industry as represented by the WCB payments range between 0.8 to 1.1, if compensation payments only are considered. When the pension payments, which include fatalities and long-term disabilities, are used the ratio ranges from 0.33 to 0.42. These are applicable only to the 'insured' sector of the industry and the 'indirect' costs include those for 'minor' injuries. These ratios are more realistic than the popular numbers used in this context, namely, 4:1, or in some cases between 2:1 and 10:1.

A selected set of comparative ratios are offered below in order to provide a perspective on some of the estimates.

The total cost of occupational injuries and illnesses is between 1.4 and 1.6% of the Gross Domestic Product (GDP) for Alberta. When subjective costs are excluded the ratio is 1.1 to 1.3%. These are higher than the comparable estimates available from the U.K. (0.54-0.87%) and West Germany (0.3 - 0.5%).

The cost is equivalent to the total GDP from the production and export of grain from the province ($822M in 1986 - Alberta Statistical Review, 1989), approximately 13% of the same from the manufacturing sectors, or approximately 6.5% of that from the Minerals sector.

The cost is 8% of the total of direct taxes on business and personal income in the province ($10.6 Billion in 1986) and 13% of the corporate profits before taxes ($6.7 Billion in 1986) (Statistics Canada Catalogue: 61-207, 1986).

The cost is $808 per year per member of the workforce and $355 per year per Albertan. Average weekly income in 1988 for Alberta is $478 (Statistics Canada Catalogue: 72-002, 1988).

The estimate for the costs outside of the compensation system, to Alberta Health, is approximately 6.6% of all payments for Basic Health Services (Alberta Hospitals and Medical Care, Statistical Supplement, 1987-88). The amount of $30 - 35M, attributed to occupationally related diseases is equivalent to the current deficit in the Hospitals budget within Alberta Health.

Total private and public sector capital investment in Alberta in 1987 was $20.3 billion (Alberta Statistical Review, 1989 and Alberta Economic Accounts, 1987). The annual cost of occupational illnesses and injuries is approximately 5% of the investment.

B. IMPLICATIONS

The direct expenditure by government in the area of prevention amounts to approximately $13M per year or $11 per year per member of the workforce. The ratio of cost to expenditure works out to be 73 : 1. If the fixed cost of prevention (not estimated in this report), is arbitrarily assumed to be 0.3% of the total investment ($20.3 billion) in all sectors at $61M per year, the cost of the occupational health and safety problem is 16 times the amount. Comparisons may be made with other areas of social and investment expenditures.

The slogan 'safety pays' may not necessarily be true for the smaller businesses. The 'indirect' cost to these companies is less than what has been believed to be in the past. Larger corporations, on the other hand, stand to derive more substantial benefits from a reduction in the size of the occupational health and saftey problem.

Compensation costs do not include a significant part of the direct costs of occupational diseases. These are funded through the general health care system. Alternate systems may be considered which will monitor and provide for such costs. A case also exists for including occupational information within the general health care data-base.

Current discussions on costs and the priorities generally centre around the payments made by the WCB. A more appropriate approach to determining priorities is through the consideration of the total costs. The design of intervention programs and incentives should take into account the estimates for all cost-centres.

Current practices and programs in occupational health and safety, within the government and industry, are largely the result of reactive measures accumulated over the years. Legislative and other preventive programs, especially in the areas of 'safety', have not been 'tested' against such measures as risks, costs of compliance and costs of the 'problem'. While such 'tests' are common within other areas of business or social policy, policies and programs on occupational health and safety need to be subjected to such considerations.

C. FURTHER RESEARCH

This report represents a preliminary effort at presenting an assessment of the costs due to occupational injuries and illnesses. The estimates in the report can be improved for accuracy within the realm of existing information through the refinement of the data. However, greater reliability of the estimate can only be achieved through improvements in the model. One example may be the incorporation of the findings of the Quebec study into the composite model. Further research or study is possible in almost all areas of the model. Some of these are suggested below.

i) Development of a standardised model, based on provincial and national data-bases, is necessary for continued use of cost information. Such a model could be operated through Statistics Canada or Health and Welfare Canada. This may be achieved through the collection of standardised cost data from industries; from the health care systems through data on occupational diseases, from WCB data-bases and through surveys of 'unreported' cases.

ii) Sample studies for Alberta on 'indirect' costs could be directed at determining the effect of the possibly significant variables e.g., type of industry, size of industry, age and training of victim, nature of injury and days lost, etc. Demographic distribution of the costs of injuries and illnesses will aid in the design of intervention programs.

iii) Studies directed at gaining hard data on the injuries and the costs within the 'uninsured' sector of the worker population in Alberta, will add considerably to the current state of the knowledge in this area.

iv) Little information is available on the 'perception of risk' in Canada, especially in Western Canada. A study and analysis based, for example, on the "Willingness to Pay" approach may yield information on attitudes and behaviour while establishing a basis for Cost Benefit Analyses for a range of social policy decisions.

v) The estimate excludes the fixed costs of prevention efforts. Data on these costs and on the total antecedent benefits of such prevention efforts are needed in order to improve the understanding of cost-issues surrounding occupational health and safety.

vi) Comparative studies are needed on expenditure/cost relationships between occupational health and safety and other areas of social investments.

vii) Studies on risks and costs of compliance are other areas which arise as follow-ups to this report.

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71-601 Results From the Absence From Work Surveys: 1978-1981, 1982.

72-002 Employment, Earnings, and Hours: Preliminary Data, 1988.

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APPENDICES

APPENDIX A

TABLE OF FORMULAE USED IN THE MODEL

(I) Cost to Industry (C_t):

$C_{LTC} = W \times [(0.25 \times 8 \times Days_C + 4 + 2) \times N_1] + W \times [0.125 \times 8 \times Days_C + 4 + 2) \times N_2]$

where,

W = Average gross industrial wage per hour,
$Days_C$ = Average Compensation days per claim,
N_1 = Number of claims in first category,
N_2 = Number of claims in second category.

The high estimate is based on :
$C_{LTC} = W \times [(0.25 \times 8 \times Days_C \times N) + 4 + 2]$
N being the total number of claims ($N_1 + N_2$).

C_{Minor} The lower and upper estimates are derived as follows :

C_{Minor} (Low estimate) = \$40 x 10 x N
C_{Minor} (Upper estimate) = $W \times [(4 + 0.5)$ hours $\times 12.5 \times N]$

C_B is calculated as follows:

$C_B = 0.2W_s \times 0.35$ X Total Compensation days X 8
$+ 0.2W_s \times 0.35 \times [(0.25 \times 8 \times Days_C + 4 + 2) \times N_1]$
$+ 0.2W_s \times 0.35 \times [(0.125 \times 8 \times Days_C + 4 + 2) \times N_2]$
$+ 0.2W_s \times 0.35 \times [(4 + 0.5)$ hours $\times 12.5 \times N]$

where,
W_s = Average hourly wage for salaried workers.

$C_M = [(0.07 \times 0.16)/(1 - 0.07 \times 0.16)] \times (C_{LTC} + C_{MINOR} + C_B + C_{PV} + P) + \$2{,}000 \times n$

where,
n = total number of vehicle accident recorded within the WCB

P = 0.05 x GDP per worker per hour x Total number of labour units lost directly and indirectly,

where,
total number of labour units lost directly and indirectly are computed in the calculations for C_{LTC} and C_{Minor}, and is equal to :

$[(0.25 \times 8 \times Days_C + 4 + 2) \times N] + [(4 + 0.5)$ hours $\times 12.5 \times N]$

$C_{uninsured}$ is estimated as :

$0.33 \times (C_{LTC} + C_{MINOR} + C_B + C_M + C_{PV} + P)$

(II) Cost to Government (C_G):

C_{WCB} is equal to the following additive components:

- Compensation and Pension Awards (Paid to the Worker)
- Vocational Rehabilitation Programs
- Treatment Costs for: Worker Rehabilitation
  AHC Payments for Direct Billings
  Medical Costs for Hospitals, Drugs, etc.

$C_{Revenue} = C_{R1} + C_{R2} + C_{R3} + C_{R4} + C_{R5}$.

Where,

C_{R1} = 0.10 x (Compensation costs + Pension awards)
C_{R2} = 0.10 x [(compensation payments X 0.10) + (pension payments X 0.50)]
C_{R3} = 0.26 X P
C_{R4} = 276 x $240 000 x 10%
C_{R5} = 0.10 x [2,888,000[1] x Average hourly wage rate]

$C_{Prevention}$ = Estimated at $2.4 M for all three years

C_{AHC} is separated into two components:

C_{AHCi} = [(AHC payments + Medical costs)/N] x 14,400
C_{AHCdis} = Obtained from Alberta Health Data

C_{UIC} = [2,888,000[1]/40] x 0.141 x Average UI payment

$C_{Long\text{-}term}$ = 276 x $240 000 x (1 - 0.10)

(III) Cost to Worker (C_W):

C_{Wins} = (1 - 0.10) x [(Total compensation payments x 0.10) + (Pension awards x 0.50)]

C_{Wunins} = 0.9 x 2,888,000 x W - C_{UIC} - 0.33 x C_B

C_{Waubj} = (# of WCB recorded fatalities + additional disease mortalities) x $532,560

Note:
1) for explanation please see page 33 of report.

APPENDIX B

VALUES OF VARIABLES AND DATA USED IN THE CALCULATIONS

VARIABLE	DESCRIPTION	1986	1987	1988
W_S	Wage for salaried workers (* includes overtime)[1]	15.02	15.28	15.76
W_H	Wage for Hourly-Paid Workers (* includes overtime)[1]	10.85	10.76	11.16
H_H	Average Weekly Hours worked - Hourly Workers (* includes overtime)[1]	30.1	30.4	30.0
H_S	Average Weekly Hours worked - Salaried Workers (* includes overtime)[1]	37.2	37.3	37.4
W	Average Gross Wage-rate (* includes overtime)[2]	13.15	13.25	13.71
$Days_C$	Average Compensation Days Per Claim[3]	55	51	53
N_1	# of Cat.1 Injuries[4]	29860	28814	30218
N_2	# of Cat.2 Injuries[4]	13218	12845	13812
N	Total Lost-Time Claims[4]	43078	41659	44030
n	Total numbers of Motor Vehicle Accidents within WCB claims[5]	971	948	979

TABLE CONTINUED

VARIABLE	DESCRIPTION	1986	1987	1988
	Total Compensation Days for the Current Year[3]	957406	822123	905746
GDP	Gross Domestic Product @ factor cost (in million dollars)[6]	55,183	57,813	61,411
	GDP per worker per hour[7]	26.7	27.8	29.6
	Average Weekly UI Payment[8]	196.82	200.08	209.14

NOTES TO APPENDIX B

1) Source: Statistics Canada: Catalogue 72-002, Employment Earnings and Hours.

2) Derived by applying the following formula:

$$\frac{(W_S \times H_S) + (W_H \times H_H)}{(H_S + H_H)}$$

3) Source: 1988 Annual Report: The Workers' Compensation Board - Alberta.

4) Source: Lost-Time Claims and Claim Rates: 1988 Summary, Alberta Occupational Health and Safety. (see Report pages 42-43 for category groupings according to the nature of injuries)

5) Source: WCB Letter May 14, 1990: Jorgensen to Ng.

6) Source: Alberta Bureau of Statistics: Alberta Gross Domestic Product 1988 Preliminary Estimates.

7) Derived by applying the following formula:

$$\frac{GDP}{1{,}182{,}000} \times \text{No. of Hours Worked/Year}$$

(No. of Hours Worked/Year = $[(H_S + H_H)/2 \times 52]8$)

8) Source: Statistics Canada: Catalogue 73-202(s), Unemployment Insurance Statistics - Annual Supplement.

APPENDIX C

ESTIMATES OF THE NUMBER OF ADDITIONAL MORTALITIES DUE TO OCCUPATIONAL DISEASES IN ALBERTA

Cause of Death	Average Total Annual Mortality in Alberta Associated with Occupation 1983-1985	Estimated Proportion and Number of Deaths %	No.
Cancer (ICD 140-239)	2980	8%	238
Pneumoconiosis (ICD 500-505)	3	100%	3
Chronic Respiratory Disease (ICD 490-496)	471	1-3%	5-14
Cardiovascular Disease (ICD 410-414) Renal Disease (ICD 580-589) Neurological Disorders (ICD 350-359)	3013	1-3%	30-90
Other Conditions	6383	-	-
TOTAL	12850	-	276-345

(*Estimates based on the Landrigan and Markowitz Report to the New York State Legislature)

The percentages/proportions are applied to the hospital and other health cost in the following tables.

APPENDIX C

HEALTH CARE DATA

1986

HOSPITAL CARE*

Diseases	Average Length of Stay (Days)	Separations	Cost Attributed to the Report
Cancer	13.10	20844	
Pneumoconiosis	14.68	188	
Chronic Respiratory Diseases	8.33	12129	
Cardiovascular Diseases	10.02	11581	
Renal Diseases	7.30	10038	
Neurological Disorders	8.15	3925	

TOTAL COST PER PATIENT DAY IN 1985/86 = $416.35[a]

FORMULA: % of Deaths Associated with Occupation X Average Length of Stay X Separations X Cost/Patient Day

COST OF HOSPITAL CARE $12.93M

AMBULATORY CARE*

Disease	# of Discrete Patients	Proportioned # of Discrete Patients	Cost of Office Visit ($)	Proportioned Cost ($)	
Cancer	45800	3664	1224349	97948	
Pneumoconiosis	153480	153480	8295239	8295239	
Chronic Respiratory Diseases	129057	2581	4271269	85425	
Cardiovascular Diseases	24885	498	1017476	20350	
Renal Diseases	3402	68	137623	2752	
Neurological Disorders	60603	1212	1598722	31974	

COST OF AMBULATORY CARE $8.53M

PROCEDURES*

Laboratory Services $86,015,934
Diagnostic Procedures $30,066,793

TOTAL COST OF PROCEDURES $116,082,727
= $116.1M

TOTAL NUMBER OF DISCRETE PATIENTS = 2133476[b]
PRO-RATED COST OF PROCEDURES = $116.1 X 0.08 $9.29M

TOTAL COST OF SELECTED OCCUPATIONAL DISEASES $30.75M

APPENDIX C

HEALTH CARE DATA

1987

HOSPITAL CARE*

Diseases	Average Length of Stay (Days)	Separations	Cost Attributed to the Report
Cancer	12.98	20659	
Pneumoconiosis	14.96	183	
Chronic Respiratory Diseases	8.03	12327	
Cardiovascular Diseases	10.82	11279	
Renal Diseases	6.91	10026	
Neurological Disorders	8.91	4101	

TOTAL COST PER PATIENT DAY = $449.66

FORMULA: % of Deaths Associated with Occupation X Average Length of Stay X Separations X Cost/Patient Day

COST OF HOSPITAL CARE $13.82M

AMBULATORY CARE*

Disease	# of Discrete Patients	Proportioned # of Discrete Patients	Cost of Office Visit ($)	Proportioned Cost ($)
Cancer	46997	3760	1334419	106754
Pneumoconiosis	161487	161487	9168653	9168653
Chronic Respiratory Diseases	132802	2656	4701265	94025
Cardiovascular Diseases	25702	514	1080049	21601
Renal Diseases	3567	71	154370	3087
Neurological Disorders	62708	1254	1734903	34698

COST OF AMBULATORY CARE $9.43M

PROCEDURES*

Laboratory Services $98,796,781
Diagnostic Procedures $33,664,038

TOTAL COST OF PROCEDURES $132,460,819
= $132.5M

TOTAL NUMBER OF DISCRETE PATIENTS = 2174077[b]
PRO-RATED COST OF PROCEDURES = $132.5 X 0.08 $10.6M

TOTAL COST OF SELECTED OCCUPATIONAL DISEASES $33.85M

APPENDIX C

HEALTH CARE DATA

1988

HOSPITAL CARE*

	Cost Attributed to the Report
In the absence of data for 1988, the previous year's costs have been assumed.	$14.0M

AMBULATORY CARE*

Disease	# of Discrete Patients	Proportioned # of Discrete Patients	Cost of Office Visit ($)	Proportioned Cost ($)	
Cancer	51217	4097	1451206	116096	
Pneumoconiosis	168921	168921	9349875	9349875	
Chronic Respiratory Diseases	130036	2601	4692553	93851	
Cardiovascular Diseases	26075	522	1091749	21835	
Renal Diseases	3776	76	174721	3494	
Neurological Disorders	64137	1283	1783914	35678	
COST OF AMBULATORY CARE					$9.62M

PROCEDURES*

Laboratory Services $99,055,930
Diagnostic Procedures $34,642,055

TOTAL COST OF PROCEDURES $133,697,985
≈ $133.7M

TOTAL NUMBER OF DISCRETE PATIENTS = 2187509[b]
PRO-RATED COST OF PROCEDURES = $133.7 X 0.08 — $10.70M

TOTAL COST OF SELECTED OCCUPATIONAL DISEASES — $34.32M

NOTES TO APPENDIX C:

* ALBERTA HEALTH CARE INSURANCE PLAN (AHCIP), CLAIMS FILE
HEALTH ECONOMICS AND STATISTICS
ALBERTA HEALTH

a) Source for the 'Total cost per patient day' was Alberta Health.

b) Source for the 'Total number of discrete patients' was "Alberta Health Care Insurance Plan (AHCIP), Statistical Supplement, 1987-88, p. 12.

c) The occupational diseases under consideration are listed below. Each are recorded using the Internal Classification of Diseases, Ninth Revision, (ICD9).

Cancer	(ICD 140-239)
Pneumoconiosis	(ICD 500-505)
Chronic Respiratory Diseases	(ICD 490-496)
Cardiovascular Diseases	(ICD 410-414)
Renal Diseases	(ICD 580-589)
Neurological Disorders	(ICD 350-359)

Alberta Health provided data according to an internal system based on the Canadian Diagnostic List Codes. These are listed below.

Cancer	15-48
Pneumoconiosis	106
Chronic Respiratory Diseases	103-105
Cardiovascular Diseases	83-84
Renal Diseases	129-132
Neurological Disorders	72

d) Diagnostic code information is not required from physicians when submitting claims for laboratory services and diagnostic procedures. Therefore, it is not possible to show a breakdown of amounts paid for laboratory services and diagnostic procedures by diagnostic group.

Annotated Bibliography

APPENDIX D:

REPORT ON THE PRELIMINARY ESTIMATES FOR THE ANNUAL COST OF OCCUPATIONAL ILLNESSES AND INJURIES IN ALBERTA

1 Advisory Council on Occupational Health and Safety. Second Annual Report. Ontario, Canada: 1980.

The purpose of this report is to consider the processes and principles for developing economic impact statements for occupational health and safety statutes and regulations. It identifies the type of economic analysis which may be conducted in an economic impact study, establishes a priority system for conducting different types of economic analyses, outlines a framework for an economic impact statement (EIS), etc.

2 Alleyne, B. C. "Hearing Loss: Can Knowing What It Costs Society Help Reduce Its Occurrence?" Edmonton: Alberta Occupational Health and Safety: 1989.

Alleyne brings attention to the issue of hearing loss as it relates to the work environment. "Researchers have stated that in eradicating a health problem, society becomes concerned enough to act only after physical, economic, social and psychological costs exceed a threshold level of maximum tolerable disutility." (secondary source - see paper) Alleyne goes on to say that his studies show that the total cost of this disease in 1987 (in Alberta) is in excess of $5 Million, which is a considerable sum of money for an occupational disease which makes up only 0.3% of all claims submitted to WCB.

3 Alleyne, Brian, Dufresne, Ronald, M, Kanji, Nasim, and Reesal, Michael, R. "Costs of Workers' Compensation Claims for Hearing Loss." Journal of Occupational Medicine, Vol. 31, No. 2, February 1989.

Alleyne et al estimated the current cost per claim to be $14, 106. There also appears to be an annual increase of 20.4% for noise-induced hearing loss claims and project that if 80% of the 450 claims submitted in 1987 are accepted, it will cost in the neighbourhood of $5 Million for Alberta WCB. Several variables were accounted for in this study. These include: age, sex, employer, occupation, industry, hearing thresholds, etc.

4 Andreoni, Diego. The Cost of Occupational Accidents and Diseases. Occupational Safety and Health Series No. 54. Geneva: International Labour Office, 1986.

A comprehensive treatment of the factors to be considered when calculating the cost of occupational accidents and diseases at the individual company and national levels. This source is a comprehensive look at the issue of costs associated with industrial injuries and disease.

5 Atherley, G. R. C., Cale, R. W., Drummond, M. F., and Kolozyn, H. "An Approach to the Financial Evaluation of Occupational Health Services." Journal of the Society of Occupational Medicine, Vol. 26, 1976, pp. 21-30.

This paper attempts to provide a method for estimating the cost incurred to the company and the employees should an injury/accident/disease occur or develop during the course of work. A mathematical approach is offered to assist in the evaluation of occupational health services. Questions concerning the overall allocation of health care resources are also discussed.

6 Atherley, Gordon. "Prevention of Occupational Deafness: A Coming Crisis?" Journal of Occupational Medicine, Vol. 31, No. 2, February 1989. American College of Occupational Medicine.

This discussion concerns the area of occupational deafness. Atherley states that this disease is a preventable but largely irreversible one. Noise levels, effects, exposure, etc., are also considered. Costs of compensation are predicted and stricter limits are recommended.

7 Atherley, Gordon. "The Centre and Occupational Health and Safety Problems in Canada." Ontario: Canadian Centre for Occupational Health and Safety, 1986. (pp. 26-28)

This report outlines some of the current issues with respect to the field of occupational health and safety in Canada. A small section (i.e. pp. 26-28) discusses fatality numbers, injury frequency rates, and WCB costs in Canada.

8 Berger, Elliott H. "Workers' Compensation for Occupational Hearing Loss." EARLOG: 1985.

This series provides a perspective on the situation by summarizing available data on the current costs of workers' compensation claims for occupational hearing loss, and by developing estimates of potential future costs, based on the American experience. The principal factor determining workers' eligibility to file for compensation is their audiometric profile. This study concludes that the estimated future hearing-related workers' compensation costs amount to $3.4 Billion (U.S.) over the next 10 years.

9 Biancardi, Michael. "The cost/benefit factor in safety decisions." Readings in Cost Benefit/Cost Control. American Society of Safety Engineers: 1985.

This article defines cost/benefit analysis as a tool used by decision-makers in dealing with uncertainty. Specifically, it is a method of evaluating alternative proposals for accomplishing a specific objective. Biancardi discusses the use of this method as it relates to measuring risk levels in the work environment, as well as some of its limitations.

10 Bird, F. E. Management Guide to Loss Control. Institute Press: Toronto, 1981.

An examination of the causes and effects of downgrading incidents, incident investigation, planned inspections, job analysis and procedures, job observation, group communications, management control, environmental health in the industry, etc., are discussed in detail in this comprehensive report.

11 Brody, B., Rohan, P.C., Letourneau, T., and Poirier, Andre. "Real Indirect Costs of Work Accidents: Results From Our New Model (Abstract No. 509)." International Conference on Strategies for Occupational Accident Prevention, Stockholm, Sweden, September 21-22, 1989.

This paper reports results of a study carried out in 1988 in Quebec, Canada covering 350 disabling work injuries in 13 manufacturing industries. Average direct and indirect costs are estimated at $1,100.00. The paper presents a multiple regression analysis with indirect costs as a dependent variable and a series of nine explanatory variables. The statistically significant variables are victim age, days lost, industrial sector, production capacity and establishment size. Finally, a model is developed whereby an employer can estimate the indirect costs- and thereby, real, total accident costs - in his firm.

12 Brody, B., and Rohan, P. "The Costs of Work Accidents in North America." On the Prevention of Occupational Accidents and Diseases - 10th World Conference: 1983.

Provides an outline of research prior to that described in (11).

13 Canada, John R., and Mahmoud A. Ayoub. "The economics of safety ... a review of the literature and perspective." Professional Safety, December 1977.

Economic considerations are normally at the core of safety and risk management decision-making. This article summarizes a broad cross-section of literature on approaches and techniques for analyzing the economics of safety problems.

14 Cannon, James A. "Economic Analysis of Hazards." Journal of Safety Research, Vol. 6, No. 1, December 1974.

This paper presents a mathematical methodology for the economic analysis of hazards. The analysis consists of 4 parts: (1) estimation of the hazard cost, (2) estimation of the costs of various solutions to eliminate or minimize the hazard, (3) elimination of the unfeasible solutions, and (4) determination of the optimal solution(s). Several examples of various phases of the analysis are presented, as well as a total analysis for a hypothetical industrial operation. The validity and accuracy of the estimates used in the analysis are discussed.

15 Chambers, L.W. "Health Profiles of the Citizens of Ontario: Health Objectives, Performance Indicators and Surveillance Techniques." Published by The Canadian Public Health Association, September 1987.

Among the many topics discussed in this report are the future trends and recommendations in such areas as occupational safety and health and accident prevention and injury control. Some areas of note are the appendices which cover leading causes of death and the potential years of life lost for these deaths.

16 Chelius, James R. "The Control of Industrial Accidents: Economic Theory and Empirical Evidence." Law and Contemporary Problems, Vol. 38, No. 3, Summer-Autumn 1974.

This article presents the result of a research project on the economic consideration of safety. It is divided into the following sections: (1) Safety as an Economic Commodity, (2) The Available Alternatives, (a) Private Markets, (b) "Ex Ante" Structured Incentive, (c) The Tort Mechanism, (d) Government Fiat, (e) The Effect of Attitudes Toward Risk, (3) Sources of Friction: Transaction Costs, (a) Information, (b) Bargaining, (c) Transferable Rights, (d) Bureaucratic Goals, (4) Some Empirical Evidence on the Control of Safety, (a) Results of the Study, (5) Implications for Public Policy, and (6) Conclusion. An appendix provides a more specific and detailed description of the empirical model used to test the impact of the alternative control devices.

17 Cochrane, H. A. "Safety Communications for Reducing Mine Accidents." Mining Congress Journal, Vol. 64, No. 6, pp. 27-29, June 1978.

The safety program of the Consolidation Coal Company (Consol) is described to highlight the effectiveness of communications in the reduction of mine accidents. Consol cut its accident rate by 60% in 5 years as a result of an intensive safety program started in 1972. A salient feature of the campaign was a safety communications program designed to heighten safety awareness among the company's 22 000 employees. The other features were the establishment of a corporate safety department with corresponding departments in each operational region. The program costs $200 000/year. (Abstract source: CCINFO disk)

18 Craig, J.L. "A Practical Approach to Cost Analysis of an Occupational Health Program." Journal of Occupational Medicine, Vol. 16, No. 7, July 1974.

This article presents a simple approach to evaluate program activities to determine general cost/benefit effectiveness of various program activities.

19 D'arcangelo, Joyce. "Repetitive Strain Injuries: A Strategy That Works." Occupational Health and Safety, Canada, Vol. 5, No. 3, pp. 20-21, 1989.

A look at how ergonomics based strategies at Northern Telecom Canada's production plant in Calgary brought the number of costly repetitive strain injuries down from 20 to 4 per year. The plan of action included an employee awareness program, treatment protocols, workplace assessment and recommendations, and a cost-savings analysis. Total estimated savings was calculated at $95, 800/year.

20 Dewees, Donald. "Economic Incentives for Controlling Industrial Disease: The Asbestos Case." Journal of Legal Studies, Vol. 15, No. 2, June 1986.

The report describes the costs imposed on an asbestos product manufacturer as a result of the asbestos disease contracted by employees. (Abstract source: CCINFO disk)

21 Doll, R. "Epidemiology and the prevention of cancer: some recent developments." Journal of Cancer Research and Clinical Oncology, Vol. 114, No. 5, pp. 447-458. Oxford: 1988.

A discussion about some recent developments in the prevention of cancer. Doll's paper is sectioned into the following areas: avoidable causes of cancer, dietary factors, cancer in China (as an example), sex hormone related cancers, viral cancers, trends in mortality, and epidemiology in the future.

22 Doll, R. "Strategy for detection of cancer hazards to man." Nature, Vol. 265. University of Oxford: 1977.

A review is made of the known agents of cancer, and the ways in which they have been detected. Some changes in cancer incidence are quite significant, especially in the case of cancer of the lung in all developed countries. Much of the variation is now attributed to the action of specific agents arising from iatrogenic causes, occupational causes, industrial pollution, other hazards, viruses, etc.

23 Doll, R., and Peto, J. The Causes of Cancer. Oxford University Press, (pp 1238-1245 and Appendix F) New York, NY. 1981.

This presents an analysis of occupationally-related cancers. These researchers negate the notion that occupationally-related cancers represents approximately 20% of total cancer mortality (OSHA Paper, 1978). A more realistic estimate of occupationally-related cancers is suggested at 2-8%, with asbestos as the leading cause accounting for 1%. Doll and Peto discuss the total effects of occupational factors and the limitations of current data.

24 Doll, Richard. "Occupational Cancer: Problems in Interpreting Human Evidence." Annual Occupational Hygiene, Vol. 28, No. 3, pp. 291-305. Great Britain: Pergamon Press Limited: 1984.

Aspects of epidemiological evidence discussed: strength of association, exclusion of bias, exclusion of confounding by geographical or social factors, exclusion of chance, value of repeated studies, relation with intensity of dose, relation with exposure duration and with time since first exposure.

25 Doll, R. "The Prevention of Cancer." Journal of the Royal College of Physicians, Vol. 11, No. 2, pp. 125-40. University of Oxford: 1977.

A review is made of the incidence, causes, and prevention of cancer, with graphic data on the proportion of all deaths attributed to neoplasms by age in England and Wales in 1923 and 1973. Topics include industrial, medical and environmental causes of cancer. It is suggested that the introduction of new carcinogens should be controlled and the contacts with chemical and physical carcinogens already in the environment should be reduced. The practical difficulties in implementing the control measures are discussed. (Abstract source: CCINFO disk)

26 Doll. R. "Relevance of Epidemiology to Policies for the Prevention of Cancer." Human Toxicology, Vol. 4, No. 1, pp. 81-96. University of Oxford: 1985.

The use of epidemiological data for evaluating carcinogenic hazards in the workplace is discussed. Problems related to data extrapolation from laboratory animals to man are reviewed. Criteria used to establish positive results in epidemiological studies are listed, and the results of selected studies on various populations, including cadmium workers, hair dye users, and consumers of artificial sweeteners are evaluated. Strategies used in the planning of epidemiology to the formation of cancer prevention policy is also considered for proven carcinogens, suspected carcinogens, and all other agents.

27 Drummond, M. F., Stoddart, G. L., and Torrance, G. W. Methods for the Economic Evaluation of Health Care Programmes. Chapter 4: Cost Analysis, pp. 39-61: 1987.

A discussion of the different approaches to the evaluation of costs and consequences is presented in this chapter. Some examples include: market valuations, clients' willingness to pay, policy-makers' and professionals' opinions.

28 Fellows, J., Gottlieb, N.H., and McAlister, A.L. "Employee Health Promotion: Organizational Correlates and Community Resources." Health Values, Vol. 12, No. 1, January/February 1988.

This article reports data from a random sample survey designed to estimate the extent of employee health promotion activities in Texas. Factors, resources, and barriers which might be associated with the adoption of these activities are also examined. The respondents reported more traditional health and safety activities than those dealing with health promotion. Alcohol and drug abuse activities were, in some cases, also more prevalent than health promotion activities. Employers, however, intended to offer more health promotion activities in the future than other types of activities. Voluntary health agencies were the community resources most frequently used by the respondent organizations. Cost and other barriers were explored as were perceived rationales for programs. The types of outside assistance most desired by the respondents were consistent with an information-gathering stage of implementation.

29 Fletcher, John A. The Industrial Environment - Total Loss Control: A Guide for Managers and Supervisors. National Profile Ltd.: Willowdale, Ontario, 1972.

Fletcher profiles the area of injury prevention, damage control, total loss control, etc. Also, what should be noted is a discussion on the preparation of action plans (i.e. health and safety measures designed to prevent injuries and illnesses in the workplace).

30 Forbes, W. F. and Thompson, M. E. "Estimating the Health Care Costs of Smokers." Canadian Journal of Public Health, Vol. 74, May/June 1983, pp. 183-90.

This paper outlines a general method of estimating the health care costs incurred because of smoking. As an illustration, the method is used to obtain appropriate cost figures for the 1980 population. These health care costs are considered separately for newborns, and other specific age groups. About 15% for males and 10% for females of per capita health care costs may be associated with smoking. These results are tentative, but it is desirable to continue monitoring the costs attributable to smoking.

31 Franke, A. and Jokl, S. "The Economic Costs of Occupational Accidents." 1975.

Empirical analysis of the macro-economic consequence of occupational accidents in the Federal Republic of Germany for 1972, in which accidents are broken down according to quantitative cost items. A total of 3.2 million notifiable occupational and commuting accidents and trivial accidents were reckoned for 1972. Costs are broken down into individual and general cost items. To increase the validity of the analysis with a view to accident prevention, special attention was paid to the individual cost items (personal injury, material damage, production losses), which it is possible to influence. The costs of medical treatment and occupational rehabilitation amounted to DM.2,030 million. Extrapolated material costs were DM.430 million. Production losses (calculated by means of a macro-economic production function) amounted to over DM.5,000 million for 1972, and to more than DM.12,000 million over the long term. The total economic costs of accidents for 1970 were calculated at DM.12,400 million - or DM.20,000 million if long-term consequences are included. The distribution of these overall costs among the State industry, and private sectors was also investigated (German).

NOTE: The only available source is this abstract provided by the Canadian Centre for Occupational Health and Safety (CCOHS). The complete version is available in German, and can be obtained by ordering it through your local library service.

32 Gibbs, G. W., and Pintus, P. Health and Safety in the Canadian Mining Industry. Centre for Resource Studies: Queen's University, Kingston, Ontario, 1978.

This comprehensive report examines such factors as health, safety, risk, occupational disease, etc., and how it relates to the mining industry in Canada. A discussion on the roles and responsibilities on the part of Governments, employers, and workers is also of significance. Costs of accidents and injuries in the mining industry is quoted. Gibbs and Pintus embark on a detailed account of such areas as silica and silicosis, asbestos-related diseases, coal workers' pneumoconiosis, occupational dermatitis, noxious gases, noise-induced hearing loss, radiation, and vibration.

33 Ginpil, Fred. "Cost Analysis of Accidents." Proceedings of the Annual Conference of the Human Factors Association of Canada: October 1987, pp. 243-245.

One of the greatest problems in industry is the increase in accident costs. Implementation of safety initiatives is a common solution, however, trying to convince management of this need may not be so simple. Therefore, a computer-based model has been developed to evaluate accident costs. The proposed approach focuses on the hidden costs of accidents instead of insured compensation costs which do not necessarily reflect the actual financial burden upon the company. The program also utilizes a more accurate method to calculate results that are specific to a particular facility whereas current approaches tend to estimate the hidden costs using general guidelines established from studies in other companies. This paper describes the proposed cost evaluation program, including the identification of cost factors and the application of the computer model in determining the cost effectiveness of new safety initiatives.

34 Grimaldi, John V. "The Worth of Occupational Health Programs: A New Evaluation of Periodic Physical Examinations." Journal of Occupational Medicine, Vol. 7, No. 8, August 1965, pp. 365-374.

Grimaldi reviews the literature in this area before describing the study he undertook. The procedure involves the implementation of a questionnaire and various medical tests.

35 Grimaldi, J.V., and Simonds, R.H. Safety Management, 3rd. Edition. Richard D. Irwin, Inc.: Illinois, 1975.

Chapter 16 of this comprehensive book outlines the subject of cost analysis with respect to occupational injuries and illnesses. They describe some of the cost elements (both direct and indirect) associated with these incidents and the impact they have on an organization. Also, a consideration of insurance cost as well as several case studies, are offered to assist the reader in further understanding of the subject matter. Appendix A of this report focuses on uninsured costs.

36 Guastello, Denise D., and Guastello, Stephen J. "The Relationship Between Work Group Size and Occupational Accidents." Journal of Occupational Accidents, Vol. 9 1987, pp. 1-9. Amsterdam: Elsevier Science Publishers.

Work group size and its effect on industrial accidents was investigated. Previous studies on the topic have been inconclusive. This study also investigated whether group size is correlated with other psycho-social variables that have been shown in the past to relate to accident rate. Subjects were 435 employees in 79 work groups drawn from 9 Midwestern metal foundries and mills. Results revealed both a linear and curvilinear component of the relationship between group size and group accident rates. A scattergram revealed a breakpoint at a group size of about 15 people above which only large accident rates occurred, but below which desperately high and low rates were observed. Size was not correlated with any of the other psychosocial variables related to accidents. Implications of the findings for accident control are discussed.

37 Hamm, R.D. "Workplace Health Promotion-Benefits, Costs and the 'Dr. Faustus Effect'." Alberta Occupational Medicine Newsletter, Vol. VI, No. 2, November 1988, pp. 8-9.

This document discusses approaches to the methods of cost-effectiveness and cost-benefit analysis, and steps used to arrive at the desired results, in relation to health promotion in the workplace. There is a breakdown of both costs and benefits involved in occupational injuries and diseases. These factors should play a significant role in evaluating preventive measures.

38 Harvey, Michael. Internal Memorandum: Cost Data: Oil and Gas Well Drilling and Servicing. Edmonton: Alberta Occupational Health and Safety - Program Support Services: 1988.

In response to an internal request, Harvey summarizes the process of obtaining cost data in the Oil and Gas Industry, purposes, objectives, obstacles, alternatives, and recommendations are discussed.

39 Harvey, Michael. Cost of Injury Accident to Employer. Edmonton: Alberta Occupational Health and Safety - Program Support Services.

This draft report considers the scope of a proposed project in determining total costs of occupational injuries and diseases. Examples, elaboration of methods used in other systems (e.g. WCB), list of cost variables, estimates of uninsured costs, and benefits of accident prevention efforts are some of the topics discussed.

40 Heinrich, H. W., Petersen, P. E., and Roos, Nestor. Industrial Accident Prevention, 5th ed. New York: McGraw-Hill: 1980, pp. 73-92.

This section considers the incidental costs of accidents, hidden costs and provides examples and case studies to further clarify the situation. The remaining chapters outline accident prevention and considers subjects like risk management.

41 Hombach, W. "Skin Protection in the Factory: A Working Program." National Safety News, Vol. 129, No. 2, February 1984, pp. 26-29.

The publication describes a programme for skin protection in a factory. In the first stage of the programme, a survey was conducted to identify the hazardous materials the means of protection in use, affected workers and operations. A skin protection plan was then developed to provide information about the most effective prevention for specific substances and circumstances. The skin care programme costs $1.00 (US)/month/employee compared with $1,500 (US)/month for a case of occupational dermatitis. (Abstract Source: CCINFO disk).

42 Hoyos, C.G., and Zimolong, B. "Occupational Safety and Accident Prevention." Advances in Human Factors - Ergonomics, 11. Elsevier: Amsterdam, 1988.

The problem of occupational injuries is discussed in brief, as well as the cost components associated with these incidents

43 Howard, W.A. "Cost of Accidents in Seven Undertakings." Personnel Practice Bulletin, Vol. 20, No. 3, 1964 (pp. 19-24).

The concepts and methods used in studies of the costing of industrial accidents in seven undertakings were reported in a previous issue of this Journal, and the application of these to the costing of industrial accidents in an undertaking was described in a subsequent issue. This article summarizes the results of the seven field studies into the cost of industrial accidents in individual undertakings.

44 Injury Awareness and Prevention Centre - Faculty of Medicine, University of Alberta. Injury in Alberta, 1989. Conference Proceedings.

This comprehensive document produced by the University of Alberta considers such areas as injury mortality (in Alberta and Canada), Hospital Morbidity Statistics, Back Injuries, Head Injuries, Financial Impact of Injuries, etc.

45 Jacobs, Philip, and Chovil, Alan. "Economic Evaluation of Corporate Medical Programs." Journal of Occupational Medicine, Vol. 25, No. 4, April 1983.

The cost of corporate medical programs is receiving increasing attention in times of financial austerity. This article reviews the published data on economic evaluations of such programs. It develops a framework within which profitability and cost-effectiveness can be assessed. Critical evaluation of the available data confirms the probable cost benefit of preemployment examinations, and absenteeism and alcohol abuse control programmes. It is noted that the data are limited to a small and unrepresentative sample of industry.

46 Kruse, Larry C. "Cost Accounting of Accidents." Professional Safety, March 1982.

A basic accounting model for accidents is presented in this article.

47 Landefeld, J.S., and Seskin, E.P. "The Economic Value of Life: Linking Theory to Practice." American Journal of Public Health, June 1982, Vol. 72, No. 6.

Human capital estimates of the economic value of life have been routinely used in the past to perform CBA of health programs. Recently, however, serious questions have been raised concerning the conceptual basis for valuing human life by applying these estimates. Attempts to implement the willingness-to-pay approach using survey responses or revealed-preference estimates have produced a confusing array of values fraught with statistical problems and measurement difficulties. As a result, economists have searched for a link between willingness to pay and standard human capital estimates and have found that for most individuals a lower bound for valuing risks to life can be based on their willingness to pay to avoid the expected economic losses associated with death.

48 Landrigan, Philip J., and Markowitz, Steven B. Occupational Disease in New York State: Proposal for a Statewide Network of Occupational Disease Diagnosis and Prevention Centers - Report to the New York State Legislature: 1987.

This chapter deals specifically with costs of Occupational Disease in New York State; more specifically, direct medical costs, indirect costs resulting from lost production, foregone opportunities and diminished investment, and non-economic costs, resulting from pain and suffering, etc. Annual costs in New York State of five occupational diseases (i.e. cancer, chronic respiratory disease, pneumoconiosis, cerebrovascular and cardiovascular disease) are estimated conservatively to be over $600 million (1985 U.S. Dollars). Evidence indicates that most of these losses are uncompensated; that is, most costs of occupational disease are borne directly by the worker or his/her family.

49 Laufer, A. "Construction Accident Cost and Management Safety Motivation." Journal of Occupational Accidents, Vol. 8, No. 4, April 1987.

The assumption that top management of construction firms (in Israel) can be motivated by economical interest to become actively involved in accident prevention of their firms, prima facie through the uninsured accident costs, is investigated. However, findings show that the average uninsured accident costs only 100 manhours, equivalent to merely 0.76% of a project's labour cost. Size of site, type of construction and cause of accident do not affect accident costs while nature of injury, injured organ and casualty's occupation do affect it. The correlation between lost days and uninsured costs is low. A methodological discussion exploring various approaches to the study of accident costs as a source for management motivation is followed by recommendations with practical implications.

50 Leopold, Ellen, and Leonard, Simon. "Costs of Construction Accidents to Employers." Journal of Occupational Accidents, Vol. 8, No. 4, April 1987.

The objective of this study based on a questionnaire survey was to derive consistent cost estimates of industrial accidents across a broad spectrum of firms within the construction industry in the UK. The study concluded that only very large firms can hope to influence the amount of the insurance premium by improving their safety performance over a period of years and that additional "hidden" costs measured by the survey are not, by comparison with insurance premiums, sufficient to act as an incentive to invest in greater accident prevention. (Abstract source: CCINFO disk)

51 Manga, P., Broyles, R., and Reschenthaler, G. "Occupational Health and Safety: Issues and Alternatives - Technical Report No. 6." Economic Council of Canada, March 1981.

Cost of occupational injuries are referred to in a section of the report. Ratios are quoted through secondary sources.

52 Manuele, F.A. "Back Injury Prevention: The Significance of Ergonomics." Professional Safety, Vol. 29, No. 2, February 1983, pp. 33-37.

A review of back injury prevention is made. Back injuries represent a large segment of employee injuries and associated costs. Thirty to 40% of compensation dollars result from back injury claims. Some preventive measures include employees selection procedures, replacement strength testing, weight load limits, lifting techniques training, physical fitness, and ergonomics. The use of ergonomics to analyze job assignments based on load limits is discussed. Modification of methods for handling reduction of work periods or avoidance of manual handling of materials are examined. The author suggests that it is the responsibility of safety professionals to encourage the use of ergonomics in the design of work areas. (Abstract source: CCINFO disk.)

53 Melinek, Stanley J. "A Method of Evaluating Human Life for Economic Purposes." Accident Analysis and Prevention: An International Journal - Vol. 6, No. 2, October 1974, Oxford.

In deciding what risks are acceptable and what precautions are worthwhile in the field of safety it is sometimes necessary to place a value on human life. Some of the methods which can be used for assessing the value of human life are: replacement cost, gross productivity, productivity minus consumption, and marginal valued Y/dn, where "Y" is the net national product and "n" the population. Melinek also proposes his own methodology, and provides some useful examples to draw from.

54 Miller, T.A., Hoskin, A.F. and Yalung-Mathews, D.H. "A Procedure for Annually Estimating Wage Losses Due to Accidents in the U.S." Journal of Safety Research, Vol. 18, 1987, pp. 101-119. (Printed in the USA)

This study proposes a procedure for estimating the cost of lost wages due to accidents with separate estimates generated for motor vehicle, work, home, and public accidents, as well as the overall total. The procedure utilized the "human capital" approach, whereby the discounted present value of lost future earnings is taken as the appropriate measure of the productivity loss to society due to accidents. Other cost estimating approaches were discussed. Using this procedure, it was estimated that accidental injuries resulted in $31.1 billion in wage losses in 1985, about 1.6% of all wages and salaries paid in that year.

55 Morgan, P., and Davies, N. "Costs of Occupational Accidents and Diseases in Great Britain." Employment Gazette, November 1981 (pp. 477-485).

This article examines the strengths and weaknesses of the data now available with the aim of revising and updating the estimates contained in Appendix 9, Part III of the Robens Report. The intent of this article is to provide some indication of the size of the problem of occupational accidents and diseases after substantial expenditure both by government and industry to reduce it. This study considers the year ending June 1979.

56 Naquin, A.J. "The Hidden Costs of Accidents." Professional Safety: 20(12), pp. 36-29, 1975.

The author describes how the indirect cost items can be identified in the case of an accident. (Abstract source: CCINFO disk.)

57 National Safety Council. Accident Facts, 1988 Ed.

This comprehensive publication presents three types of information association with accidents in the workplace: current estimates, historical tables and special articles.

58 National Safety Council. "Accident Records and Incidence Rates, Accident Investigation, Analysis and Costs, and workers' Compensation Insurance. Accident Prevention Manual for Industrial Operations, Administration and Programs, Chicago: 1988 pp. 113-182.

The 3 chapters being considered discusses accident records and incidence rates; accident investigation, analysis and costs; and workers' compensation insurance. These areas all relate to the U.S. experience; however, much of it can be applied to Canada.

59 National Safety Council. "Documentation of National Safety Council Statistics Department: Estimating Procedures for Motor-Vehicle, Work, Home, and Public Deaths and Death Rates." Statistics Department, February 1982.

The National Safety Council Statistics Department makes annual estimates of the number of accidental deaths and death rates. "Work" is broken down by major industry group as defined in the Standard Classification Manual (1972).

60 National Safety Council. "Estimating the Cost of Accidents, 1987." Prepared by the Statistics Department. Printed in the U.S.A. (unpublished paper).

This document provides a useful way to measure the value of accident prevention through an estimate of accident costs. Relevant definitions are also provided for the reader's convenience.

61 O'Neill, B., and Kelley, A. B. "Costs, Benefits, Effectiveness, and Safety: Setting the Record Straight." American Society of Safety Engineers, 1985.

Aside from analyzing the two terms, the two authors take the following viewpoint: The concepts of "cost-benefit" and "cost-effectiveness" are increasingly introduced to justify a particular standard. Because of the major conceptual and methodological difficulties in the valuation of life and limb, cost-benefit studies will be appropriate only in the evaluation of designs not primarily intended to save lives and reduce injuries. Until firms are forthcoming with accurate cost data, neither cost-effectiveness nor cost-benefit studies in this field can be relied upon.

62 Pedersen, E., Hogetvelt, A. C., and Andersen, A. "Cancer of Respiratory Organs Among Workers at a Nickel Refinery in Norway." International Journal of Cancer, Vol. 12, No. 1, pp. 32-41. Norway: 1973.

A follow-up study has revealed an increased incidence of cancer of respiratory organs among men employed at a nickel refinery in Norway. The highest risk was among men involved in roasting, smelting, and electrolysis. For these men, the ratio of observed to expected number of cases was 7:1 for lung cancer and 40:1 for cancer of nasal sinuses. Still higher relative risks were found for workers of these categories whose employment had started before 1940.

63 Pines, A., Halfon, S. T., and Prior, R. "Occupational Accidents in the Construction Industry of Israel." Journal of Occupational Accidents, Vol. 9, 1987, pp. 225-243. (Elsevier Science Publishers: Amsterdam)

The long-term trends and current occupational accident statistics in the Israeli construction industry have been analysed. It has been found that occupational accident incidence and severity rates decreased little, if at all, during the last decades, and at present head the list of economic branches ranked by the degree of work accident risk. Almost all those injured were males; the proportion of commuting accidents to total occupational accidents was half the national average. The most prevalent accident causes were falls, falling objects and collisions with foreign bodies. Most injuries were contusions and would damaging mainly upper limbs, although less often than in other economy branches; whereas foot, trunk, head, and neck injuries were more frequent in construction workers. Among recommended preventive actions, such as implementation of safety measures, professional and safety education of workers, etc., increasing insurance premiums for building contractors with unsatisfactory safety ratings seems to be a promising incentive for the improvement in work safety. The main areas of further research are outlined.

64 Priest, W. Curtiss. "Cost-Benefit Problems in Safety and Health Evaluations." Hazard Prevention, Winter 1979.

This article discusses some of the problems associated with health and safety evaluations. The major issues include: Determining the worth of Reducing a Hazard; Determining What Level of Hazard Reduction Will Occur; Current State-of-the-Art Tradeoff Analysis; and Future Needs for Cost-Benefit Analysis.

65 Report of the Task Force on the Workers' Compensation Board (Alberta), 1988.

The paper, prepared by the Workers' Compensation Board, made 8 recommendations toward an improved and better system. These include: (1) the focus of the WCB's activities should be on rehabilitation rather than compensation; (2) a "wage loss" method should be adopted to compensate injured workers; (3) the concept of universal industry coverage should be accepted; (4) an internal appeal system should be maintained; etc. Further elaboration is provided on each.

66 Reschenthaler, G.B. The Economic Impact of Occupational Health and Safety Regulation. Edmonton: University of Alberta - Faculty of Business: copyright date unknown.

A consideration of the role of economic analysis in the administration of occupational health and safety programs. Some of the variables associated with this study is GNP, inflation, productivity, and innovation. Reschenthaler also looks at measurements of costs (e.g. total cost to employers, etc.).

67 Rice, Dorothy, P., MacKenzie, Ellen, J. and Associates. Cost of Injury in the United States - A Report to Congress. San Francisco, CA: Institute for Health & Aging, University of California and Injury Prevention Center, The Johns Hopkins University, 1989.

This report focuses attention on all types of critical public health issue. It examines such important topics as incidence of injury, the economic cost of injury, the source of payment, the theory of 'Willingness to Pay', potential savings from injury prevention, long-term impact of injury on individuals, families and society, and provides recommendations for prevention, control, treatment, and rehabilitation. Several relevant tables are also presented for consideration.

68 Rinefort, Foster, C. "A New Look at Occupational Safety . . . a cost-benefit analysis of selected Texas industries." Readings in Cost Benefit/Cost Control. American Society of Safety Engineers: 1985.

This article summarizes some of the results of a study of the safety activities and work injuries of 140 Texas chemical, paper, and wood manufacturing firms. A statistical analysis of the data indicated that a subtle combination of highly interrelated safety activities best reduced work injuries. A CBA concluded that the most cost-effective safety activities were: safety rules, off-the-job safety, safety training, safety orientation, safety meetings, and medical facilities, supplies, and staff.

69 Rinefort, Foster, C. "The economics of safety - How much risk is acceptable, if any?" Readings in Cost Benefit/Cost Control. American Society of Safety Engineers: 1985, p. 27.

This article reviews both selected discussions of the subject and those studies which were judged to be the most complete or most relevant. Some of the areas considered were: The valuation of human lines; Effects of workmens compensation insurance; Wage differentials; Government intervention; Qualitative studies; and Cost-Benefit Analysis Approaches.

70 Robens Committee, 1972. "Safety and Health at Work." Report of the Committee 1970-72 (pp. 139-141 and Appendix 9).

This study looks at the costs of accidents in Great Britain. It is estimated that the total cost to the nation ranged from 200 - 900 million British Pounds annually. The appendix presents the methodologies used in attaining these results. Coal mining is used as an example to further elaborate on their theory, and a complete list of cost factors is presented to the reader. Occupational diseases and fatalities were also considered.

71 Rohan, Paul, C. and Brody, Bernard. "Frequency and costs of work accidents in North America, 1971-80." Labour and Society, Vol. 9, No. 2, April-June 1984. Ottawa: International Labour Organisation: 1984, pp. 170-171.

In recent years, accidents have been the third most important cause of mortality in North America. Their economic cost is considerable. While it is practically impossible to express human suffering, death, permanent disability, etc., in numeric values, the direct expenses and indirect costs of work injuries may partially illustrate the magnitude of the socio-economic burden related to work accidents and their consequences. In Canada, the trend is worsening. A look at the situation in current and constant dollars is also among the highlights.

72 Schramm, Carl J. "Measuring the Return on Program Costs: Evaluation of a Multi-Employer Alcoholism Treatment Program." American Journal of Public Health, Vol 67, No. 1, January 1977.

The purpose of this paper is to illustrate how cost savings resulting from an industrial alcoholism program can be conservatively estimated by using hourly wages as a direct proxy for the value of production not lost by problem drinking workers. Another goal was to develop a return on investment model to measure cost savings attributable to the program. Reduced labor turnover costs, fewer on-the-job accidents, improved work-group morale, lower medical care costs, and a reduction in the number of grievance hearings and labor arbitrations are just some of the benefits derived from this program.

73 Sheridan, Peter J. "What are accidents really costing you?" Occupational Hazards, March 1979.

This report outlines some of the costs associated with occupational injuries and diseases, so that firms have an idea regarding the costs and, therefore, make informed decisions about investments in a safety program. Examples include: direct compensation paid, time lost, equipment damage, etc.

74 Simonds, Rollin H. "What Are The True Costs of Accidents?" National Safety News. USA: 1955.

This article proposes some of the cost factors incurred as a result of a work injury/accidents, and offers a few suggestions so management can obtain a reasonable and accurate estimate so as to make an informed decision.

75 Stout, Theodore B., and Johnson, Nadine P. "Using Incident Analysis In The Creation of a Safe Workplace." Proceedings of the Annual Conference of the Human Factors Association of Canada: October 1987, pp. 91-94.

Designing for people's inabilities through ignorance or otherwise, decreases performance and profits. Therefore, a computer analysis of accident and injury data can be a useful tool in the creation of a safe, and therefore, more profitable, workplace. This paper addresses the following issues: Is incident analysis feasible? If so, what types of information can and should be gathered? What types of reports should be generated? What use will the reports be in creating a safer and healthier workplace?

76 Thaler R., and Rosen, S. "The Value of Saving a Life: Evidence from the Labor Market." Preliminary Report Prepared for the Conference on Research in Income and Wealth. New York, National Bureau of Economic Research, 1973.

Thaler and Rosen estimated the marginal valuations of safety for a select group of individuals in 1967. Some of the topics include: The Market for Job Safety, Supply Price of Job Risk, Demand Price for Job Risk, Market Equilibrium, etc. A case study is also presented for further elaboration.

77 Tsai, S.P., Bernacki, E.J., and Dowd, C.M. "Incidence and Cost of Injury in an Industrial Population." Journal of Occupational Medicine, Vol. 31, No. 9, September 1989.

Using both occupational and non-occupational data, the nature and magnitude of injuries were determined in a working population of 20 705. Approximately 1/3 of the population sustained an injury in 1986. Men experienced a significantly high injury rate than women and hourly employees had significantly high incidence rates than salaried employees. The majority of non-occupational injury claims were for low back disorders, whereas most occupational injury claims were related to superficial wounds and contusions. Overall, the incidence of non-occupational was twofold higher than that of occupational injuries. Total costs of occupational and non-occupational injuries were $4.97 million.

78 Vaupel, J. W. "On The Benefits of Health and Safety Regulation." The Benefits of Health and Safety Regulation. Eds. A.R. Ferguson and E.P. LeVeen. Ballinger Publishing Company: Massachusetts, 1981.

Among the subjects that this article covers include the unequal distribution of losses, evidence pointing to the notion all mortality and morbidity could be reduced, the range of policy options, etc. Vaupel discusses the rationale for health and safety regulation and the benefits that are a direct result of this form of regulation.

79 Verhaegen, P., Strubbe, J., Vonck, R., and Van Den Abeele, J. "Absenteeism, Accidents and Risk-Taking." Journal of Occupational Accidents, Vol. 7, 1985, pp. 177-186. Netherlands.

In a seminal study Hill and Trist (1953) found a relationship between accidents and absenteeism. This relationship was confirmed in a series of statistical analyses, carried out at different times in five different firms and involving data of hundreds of accidents. This relationship was especially significant for accidents in which the victim had been active. One plausible explanation is that active accident victims display a more negative attitude towards their firm and its safety rules. So, they ignore some of these rules, which leads to more risk taking in their work. This explanation was confirmed by an interview and questionnaire study of ten accident-free workers, ten workers who had an accident in which they had been passive, and ten workers who had been victims of an accident in which they had been active.

80 Warner, K.E., Wickizer, T.M., Wolfe, R.A., Schildroth, J.E., and Samuelson, M.H. "Economic Implications of Workplace Health Promotion Programs: Review of the Literature." Journal of Occupational Medicine, Vol. 30, No. 2, 1988. American Occupational Medical Association.

The conventional wisdom holds that workplace health promotion (HP) programs yield financial dividends, often generating cost savings. To examine the intellectual and empirical basis for this belief, Warner et al reviewed the literature on the economics of workplace HP programs. In general, in the literature published through early 1986, the claims of HP programs' profitability are based on anecdotal evidence or analyses seriously flawed in terms of assumptions, data, or methodology. Furthermore, certain aspects of the economics of HP programs have been virtually ignored. The dearth of sound evidence on the economic merits of workplace HP should not be interpreted as a negative assessment of the potential of such programs, however.

81 Wolfe, Richard A., and Ulrich, David O. "Employee Health Management Programs: Review, Critique, and Research Agenda." Journal of Management, Vol. 13, No.4, 1987, pp. 603-615. Southern Management Association.

Employee health management programs (EHMPs) have been receiving increased attention. This paper argues that studies assessing the effect of EHMPs on individual and organizational outcomes have great potential for managerial/organizational research and practice. It proposes a framework that integrates previous employee health management program (EHMP) research from diverse disciplines. It also suggests a research agenda that indicates how management scholars may make a significant contribution to EHMP research, to an understanding of organizational functioning, and to improved organizational performance.

SECONDARY SOURCES:

82 Heinrich, H. W. Industrial Accident Prevention. New York, McGraw-Hill, 1931 (1st Ed.) and 1959 (4th Ed.)Protective Equipment -Analysis of Accident Costs, Economic Aspects." 1984.

* Source: Canadian Centre for Occupational Health and Safety - Information Disk.

STATISTICAL REFERENCES

83 Alberta Occupational Health and Safety. Lost-time Claims and Claim Rates: 1986, '87, '88 Summary. Produced by Michael Harvey, 1989, pp. 3, 5-6, 36.

Focus is on Alberta's experience. This document outlines the highlights of the year in question. A discussion of major industry groups and their status with respect to lost time claims and claim rates, man-year estimates and claim rates by detailed industry groups, and a description of lost-time claims based on source of injury, type of accident, nature of injury, and part of body injured is included.

84 Alberta Treasury - Bureau of Statistics. Alberta Statistical Review, Second Quarter, 1989.

This quarterly report contains 82 tables distributed among various sections. These include population, labour force, income, prices, gross domestic product, investment, international trade, finance, energy and natural resources, and other primary industry groups. The selection of data has been compiled from a variety of sources. The focus is on Alberta, but information from other provinces are also included for comparative purposes. A section on definitions is also provided for users.

85 Alberta Treasury - Bureau of Statistics. Alberta Economic Accounts, 1987.

The focus of this report is Alberta and its economic situation. Some of the sections outlined here are: summary of the expenditure account and income account. A more detailed look at gross domestic product and other economic accounts are included. Consolidated tables, industry tables, consumer expenditures, personal income, exports and definitions are also considered.

86 Alberta Hospitals and Medical Care. Annual Report, 1987-88.

This publication focuses on health care in Alberta for 1987-88. The Alberta Health Care Insurance Plan (AHCIP), Hospitalization Benefits Plan, etc., are some of the areas which are examined in detail.

87 Alberta Hospitals and Medical Care. Statistical Supplement: Alberta Health Care Insurance Plan, 1987-88.

This supplement provides graphs of many of the factors covered in the Annual Report. Distribution of persons covered for benefits, average payment per person covered for basic health services, and average number of services per person for basic health services, etc., are examples. Where applicable, age and sex is also provided. Statistical tables are provided for such areas as medical benefits, distribution of discrete medical patients by age group, sex, and payment range.

88 Feature Articles. "Work Absences and Compensation, 1979-86" by Jean-Marc Levesque as a supplement to the Labour Force.

This article analyses the survey results for the period 1979-1986 and describes some of the major trends in work absences and the types of financial compensation received. The principal focus is on absences due to illness or accident. Highlights and tables are included in the document.

89 Labour Canada. Employment Injuries and Occupational Illnesses, 1981-84. Ottawa: The Minister of Labour, Government of Canada, 1986.

This statistical reference covers the federal jurisdiction industries and federal government, with respect to work injuries. Details include: work injury incidence rate for all industries, disabling injuries and its frequency rates, injury rate by company size, estimated work days lost, estimated direct and indirect costs of work injuries, analysis of work injuries based on nature of injury, body part injured, accident type, source of injury, and activity at the time of accident. Respective tables are also included.

90 Labour Canada. Industrial Accident Costs (1969-1979). Occupational Safety and Health Branch, March 1983.

This document considers such factors as costs and associated problems, workdays lost and injuries, accident prevention costs, capital spending on accident prevention in Canadian industries, estimated costs of compliance with occupational safety and health legislation, WCBs' Accident Prevention Expenditures in Canada, occupational safety and health joint committees - costs and funding, cost effective safety activities, and work injury costs and days lost for employers under federal jurisdiction. Respective tables and appendices are included.

91 Labour Canada. Report of the Project Steering Committee (Cost-Benefit Analysis of WHMIS - Appendix 12). April, 1985.

This appendix summarizes the report on a "Socio Economic Impact Analysis of the Workplace Hazardous Materials Information System". It describes the general methodology of the cost-benefit analysis as well as the results and their implications. The objective of this type of analysis is to measure the costs and benefits resulting from a specific project and to identify that option which provides the most cost-effective solution.

92 The Workers' Compensation Act - Alberta. General Regulations - Alberta Regulation 427/81.

Provides details regarding the Appeals Commission, Jurisdiction of Board, Compensation Entitlement, Application and Payment, Disability, Death, Medical Aid, Vocational Rehabilitation, Accident Fund and Assessments, as well as a discussion about the roles of the Board. The supplement to the Act contains a list of exempted industries and any amendments made to the original Act.

93 Workers' Compensation Board - Alberta. Annual Reports for 1986/87/88.

The annual reports outlines a summary of activities or main points for the year in question. Details include the number of claims reported, re-opened, non-compensable claims, disability awards, accepted fatalities, claim costs, number of new claim appeals, number of registered employers, number of industry accounts, assessment revenue, average assessment rate, unfunded liability, and a comprehensive look at the financial statements.

Statistics Canada Catalogues:

94 11-010 - Canadian Economic Observer, 1988

Provides readers with timely information on a broad range of economic statistics in over 100 pages of tables and charts. The regular section provides an overview of current monthly economic conditions and updates to the quarterly System of National Accounts while a featured article in each issue covers topics of current interest and/or technical notes on new methodological developments at Statistics Canada. This publication is a merger of: 11-003 Canadian statistical review; 13-005 Current economic indicators; 13-006 Quarterly economic summary; and 13-007 Quarterly economic summary, statistical summary.

95 12-501E - Standard Industrial Classification Codes, 1980

Classifies establishments to industry classes on the basis of their principal activities. The basic concepts of the 1980 edition of the classification are the same as the 1970 edition though some conceptual refinements have been incorporated - the number of divisions has been increased, the coding structure has been made hierarchical and a four-digit class level has been added.

96 13-001 - National Income and Expenditure Accounts, 1988

Contains gross domestic product and its principal components, sources and disposition of personal income and gross saving, government revenue and expenditure by level of government, transactions of residents with non-residents, gross national expenditure in constant (1971) dollars, implicit price indexes, analysis of recent trends and occasional short articles of a technical or analytical nature. A quarterly information bulletin containing preliminary data is available from the Income and Expenditure Accounts Division.

97 13-201 - National Income and Expenditure Accounts, The Annual Estimates, 1988

Contains series for breakdowns of sector accounts including industrial distribution of gross domestic product, geographical distribution of personal income, and government revenues and expenditures. Contains summary and special detail tables and reconciliation statements. Measures components of gross national expenditure in constant dollars. CANSIM matrix numbers are provided for all tables.

98 15-204 - Aggregate Productivity Measures, 1987

This annual catalogue presents indexes of labour productivity, unit labour cost and other related data. The tables are divided among various industries and takes a national perspective.

99 31-003 - Capacity Utilization Rates in Canadian Manufacturing, 1988

Presents capacity utilization rates for Canadian manufacturing by major group according to the 1980 Standard Industrial Classification, as well as aggregates for durable, non-durable and total manufacturing. The series are an analytical extension of the capital stocks series presented in publication 13-211: Fixed capital flows and stocks.

100 31-203 - Manufacturing Industries of Canada: National and Provincial Areas, 1985.

Principal statistics for Canada and provinces by industry group, historical and other tabulations. Includes data by type of organization and size of establishment starting with the 1977 issue.

101 61-207 - Corporation Financial Statistics, 1986

Contains aggregate balance sheet, income and expense, profit and retaining earnings information for corporations classified by 182 industries. Since 1969, the previous year's revised data (as well as current year's financial items) are included, along with the 15 commonly used key ratios. Also includes sources of data and coverage, methodology, data quality, definitions and bibliography.

102 61-208 - Corporation Taxation Statistics, 1988

Taxation of corporation income, indicating the industries earning the income on which income tax is based, the province in which that income is earned and a reconciliation of corporation profit with taxable income and with taxes, including a general review and analysis of the data presented for the reference year. Included also are: technical notes, definitions, data sources, methodology and bibliography.

103 61-208P - Corporation Taxation Statistics, Preliminary Data for Income Taxes and Provincial Allocation of Taxable Income, 1988

Estimates, based on partial data, of federal and provincial corporation income taxes and taxable income by province, for major industry groups. Includes data analysis.

104 71-001 - The Labour Force, May 1989

Presents seasonally adjusted and unadjusted estimates of labour force, employment and unemployment, with unemployment and participation rates analyzed by selected geographic, demographic and occupational variables. Includes updates to historical series contained in 71-201, occasional special analyses and sample questionnaire, definitions, list of economic regions and bibliography.

105 71-601 - Results From the Absence From Work Surveys, 1978 to 1981, 1982

Presents and analyzes selected results from the surveys concerning paid workers (employees) who were absent from work for a period of two or more consecutive weeks due to illness, accident or pregnancy at some time during the previous year. Originally issued as 71-X-503. Includes data analysis, notes, and survey questionnaire.

106 72-002 - Employment, Earnings and Hours, Preliminary Data, 1988

Industry and area data on industrial employment, average weekly earnings, average weekly hours, average hourly earnings. Previously Employment, earnings and hours.

107 72-208 - Work Injuries, 1985-87

Provides information on work related injuries and illnesses in Canada. The data are tabulated by province, nature of injury, source of injury, type of accident and part of body injured. In addition, these statistics are related to the sex, age and occupation of the injured worker, and the industry of his or her employer.

108 73-001 - Unemployment Insurance Statistics, December 1988 (Monthly)

Presents data on unemployment insurance: estimates of the insured population; claims received; claims allowed; final beneficiary accounts; weeks and amount of benefits; disqualifications and disentitlements. This document also includes relevant tables with data breakdowns of provinces.

109 73-202(s)- Unemployment Insurance Statistics: Annual Supplement (1988)

Provides information on the development of the Canadian Unemployment Insurance Program, the technical notes for the monthly report, and historical statistics. The unemployment insurance statistics time series published in the annual supplement includes data on the number of claims for benefits received, the number of benefit weeks paid, total benefit disbursements, average weekly payments, the number of disqualifications and the number of beneficiaries. Where applicable, the data are detailed by sex, type of benefit, month and province. In addition, the annual supplement features complementary statistics, including wages and salaries paid in Canada, maximum and average weekly unemployment insurance benefits expressed in current and 1981 dollars, average weekly earnings, and the number of unemployed by region as measured by our Labour Force Survey.

110 74-401 - Pension Plans in Canada, 1988

Data are included for all occupational pension plans sponsored by employers in both public and private sectors. Also included are contributions to RRSP's as well as vesting, contribution and benefit rates, eligibility conditions, integration of private plans with the Canada and Quebec pension plans, retirement ages, contributions paid into plans by employers and employees, pension indexing and pensioners.

111 82-206 - Cancer in Canada, 1985

New cancer cases diagnosed and reported to provincial tumor registries. The system provides a large base of information for the study of variations in cancer incidence by person characteristics and geographic region and to allow the monitoring of trends in cancer incidence over time. Included are history, data analysis, data sources, glossary and bibliography.

112 82-208 - Surgical Procedures and Treatments, 1987

Counts of primary surgical procedures in general and allied hospitals. Includes data analysis, definitions, methodology and Canadian Classification Procedure and the Corresponding Canadian Procedure Short List, and bibliography.

113 83-002 - Quarterly Hospital Information System, Hospital Indicators, 1987

Participating hospitals received reports containing utilization and cost indicators. This publication presents some 32 of these indicators in a format that allows comparison of hospitals grouped according to type and size and province. Summary statistics for these hospital groupings include arithmetic mean, standard deviation and quartiles.

NOTE: The abstracts provided for Statistics Canada Catalogues, were taken from Statistics Canada Catalogue - 1987-88: Ottawa, Minister of Supply and Services Canada, 1988.

MISCELLANEOUS REFERENCES

114 Alberta Agriculture. Internal Reports on Fatalities and Injuries, 1986-1988.

115 Alberta Consumer and Corporate Affairs. Memo from Bernard Rodrigues on information regarding "Self-Insurance" with respect to occupational injuries and illnesses.

116 Canadian Cancer Statistics, 1986-88.

117 Edmonton Ambulance Authority. Dan Bishop - on frequency, nature, and costs of incidents requiring an ambulance.

118 "Environment Scan" - Internal Document prepared by Alberta Occupational Health and Safety for Strategic Planning, 1989.

119 Insurance Bureau of Canada. Alan Wood - Information regarding private insurance (i.e. numbers and costs). "Canadian Life and Health Insurance Facts, 1988 Edition". Other insurance data is located in the "Commercial Lines Statistical Exhibit, Fall 1987.

RECOMMENDED READINGS

Ashford, N. Crisis in the Workplace: Occupational Disease and Injury. Cambridge, Mass.: MIT Press, 1977, 589 pp. several chapters on "Economic Issues".

Bundy, M. "The Rising Cost of Illness. Absence in Industry." American Journal of Public Health, Vol. 57, No. 1, pp. 137-142, 1967.

Economic and Empirical Aspects of Industrial Safety. Rochester University, prepared for the Department of Labour, February 1974.

Drummond, M.F. Principles of Economic Appraisal in Health Care. Oxford, England: Oxford University Press, 1980, pp. 27-58.

Herbert, J.H. "A Policy Model of Industrial Accidents Using Economic and Business Activity Variables." Applied Economics, 1979. 11, 211-220, Printed in Great Britain, Chapman and Hall Ltd.

Howard, W. A. "Costing of Industrial Accidents - Concepts and Methods." Personnel Practice Bulletin, Vol.19, No. 3, pp. 24-31, 1963.

Howard, W. A. "Cost of Accidents in a Victorian Building Materials Factory." Personnel Practice Bulletin, Vol. 19, No. 3, pp. 23-32, 1963.

Kunz, W. "Cost of Occupational Accidents to the Enterprise." 1984.

Kunz, W. "Occupational Accidents Due to the Absence of Personal Protective Equipment Analysis of Accident Costs, Economic Aspects. 1984. Allgemeine Unfallversicherungsanstalt, Abteilung fur Unfallverhutung und Berufskrankheitenbekampfung, Adalbert-Stifter-Strasse 65, 1200 Wien, Austria, no date. 60p. Illus.

Nill, E. The Cost of Occupational Safety. Practical Considerations, Vol. 23, No. 7, pp. 314-319, 1972.

Oi, Walter Y. "On the Economics of Industrial Safety." Law and Contemporary Problems, Vol. 38. Summer-Autumn 1974, No. 4.

Paul, Betty Clayton. "Absences From Work Due to Illness." Labour Force Canada, pp. 91-100, 1984.